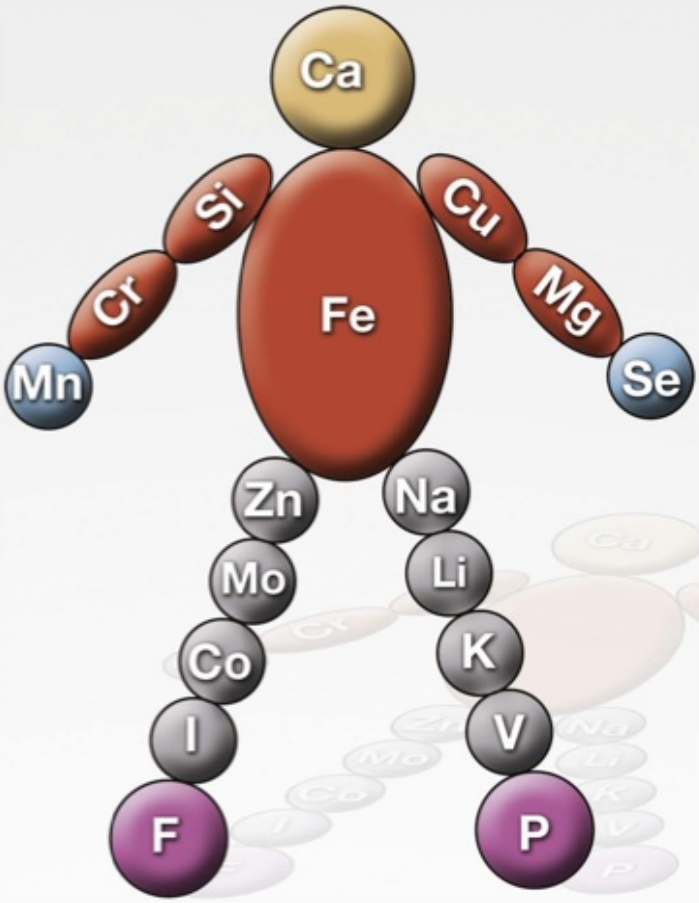
METALLURGY IN OUR BODY



AUTHOR
Dr. İLHAMİ PEKTAŞ

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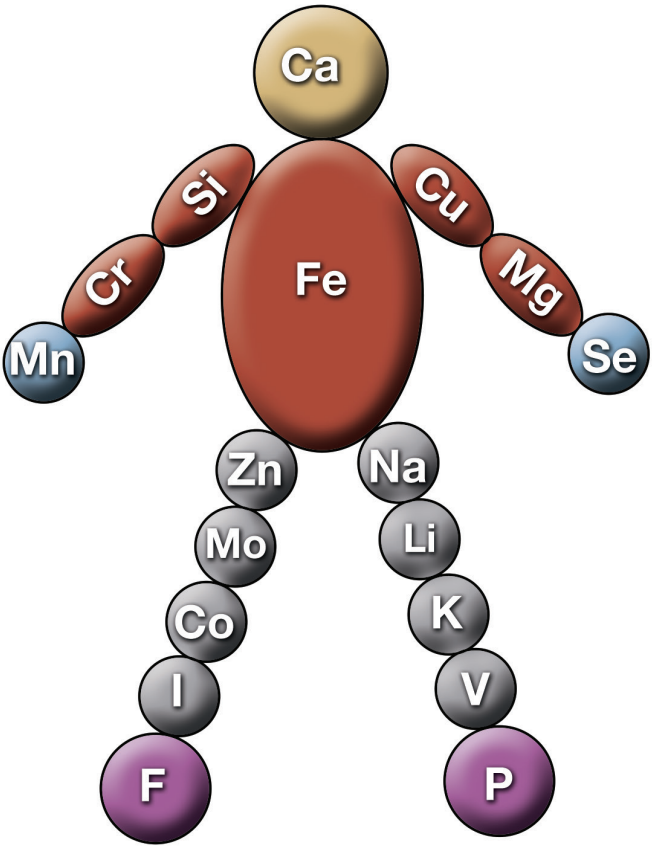

AUTHOR

Dr. İLHAMİ PEKTAŞ

Dr. İlhami PEKTAŞ
100. Yıl Bulvarı 101/A Ostim-ANKARA
Tel : 0312 354 92 10
Faks : 0312 354 58 98
E-mail : ilhami.pektas@ostim.com.tr

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PREFACE

Minerals, metal ions, metal filling, prosthesis and implant materials, which take an important place in our bodies, have led me to do research in this regard from the perspective of a metallurgical engineer. Naturally balanced and unbalanced nutrition, metallic materials which substitute our organs that have lost their normal function, as filling, prosthesis and implant materials with the environmental effects which are being polluted quickly today, have reached important proportions in our bodies.

Especially in the last years, over the counter supplements consumed unconsciously, chemical food additives unrestrainedly added in foods and incoming elements and compounds due to the extreme environmental pollution can be life threatening.

The natural elements that our bodies need, the poisoning metals that result from both the environmental pollution and additives, and the metal materials that are placed in our bodies with operation that can do the same thing with the organs which lost their function in our bodies are discussed in this book.

I would like to express my gratitude to my wife Duriye, my daughter Merve and my son Bahadır Pektaş for their great patience and supports and Lamia Avşar, Prof. Dr. Ali Ceylan and Prof. Dr. Halil Başar who contributed for their supports during the preparation of this book.

I feel lucky if I contribute to a different perspective on our bodies and health.

Take care of yourselves….

Dr. İlhami Pektaş

PRESENTATION

The purpose of all the sectors, especially the health sector, is to enhance the welfare of the society, improve human health and create healthier societies. Disorders in genetic, hormonal and metabolic activities, constitutional factors such as low levels of basic substances like vitamins and minerals have an influence on our health positively or negatively. On the other hand, humans are in interaction with the environment they live until they die. While taking the substances that our bodies need less than the required amount leads to the significant disorders, excessive intake causes various diseases and poisoning. For example, the heavy metals used in the industry reach to the air, soil, water and ultimately to the plants and people by the way of the food chain through industrial wastes unrestrainedly thrown.

Those who are interested in human health accept that preventing diseases is a more rational way than treatment and costs less. Important tasks fall to the employees in every stage of the society and in every sector for protecting health.

When I evaluated this book in this point of view, I saw that I have presented the functions in the body, required daily amounts and main sources of the basic elements necessary for healthy living in the nature in a plain and fluent language. In addition, it has been an important reference guide for the reader that presents evidence-based information on areas of usage, negative impacts of heavy metals used extensively in the industry to enhance the welfare and especially the measures to be taken in terms of health.

And good examples have been given in the field of biomaterials, which are increasingly used today instead of the organs that lost their function in a language based on materials and metallurgy.

I sincerely congratulate İlhami Pektaş who brings us a useful work in terms of protecting the health of society and creating awareness.

Prof. Dr. Ali CEYLAN
Health Specialist
Dicle University
September 2015

We can also think of the human body as an integrated system ranging from cells to tissues, from tissues to organs, from organs to systems such as cardiovascular, five sensorial, nervous, urinary and reproductive and running in an astonishing harmony and wholeness. In addition to the ions and metal elements which are physiologically necessary, this integrated system also contains toxic metals to run..

In this book, the subjects including how the minerals, ions and metals which are essential and nonessential for body organ physiology and food additives, which role they play in human life, which toxic events and disorders they cause when they are taken less or excessive amounts than required are discussed in an original, clear and plain language. In particular, chronic metal poisonings and diseases that can be seen in industrial workers working in chemical industry and metallurgy are indicated and the risks of food additives are explained.

Moreover, biomaterials, which substitutes our organs that lost their functions, have recently entered in the development process and their successful applications until today are explained in a clear way in this book.

As a medical scientist, I would like to express my belief that this book, which clearly and comprehensively explains "the role of metal elements in the physiology of the body organism" from a Metallurgical engineer's point of view, will be beneficial to the readers at every level.

Prof. Dr. Halil BAŞAR
Oncology Hospital
Department of Urology
September 2015

INTRODUCTION

The human body is so perfectly created that all body cells, except the brain and heart cells, constantly renew themselves. We have approximately 70 billion cells and DNA of 126 billion kilometers in length in our bodies. There are 125 thousand genes on DNA. Our body creates about 10 million new cells per second, as well as 6-7 million cells die per second. Stomach lining cells are renewed every few days, skin cells - every 2 weeks, nose cells - every month, fatty tissue - every 3 weeks, red blood cells - every 2-3 months, liver cells - every few years and all glands in our bodies - every 7 years. During body renewal, patient organs, injuries are rapidly healing and some cancer cells are being thrown out.

Large absorbent surfaces are formed in the villi of 1 mm in length and 0.1 mm in thickness in the small intestine. It takes between 30 and 120 hours for food to be chemically processed and made available to the organism. Incredibly large inner surface and continuous cell renewal are its interesting features. 100 m^2 area is fitted in the length of 5 m in the small intestine, and this epithelium of 100 m^2 is renewed in only 3 days. The kidneys are the vital organs that provide the continuation of human life by filtering toxic substances in the human body with 1 million nephrons of 100 km in length when attached end-to-end. Our kidneys, which constantly work all day long, drain about 180 liters of blood and dispense 1-1.5 liters of urine as waste.

There are billions of nerve cells in the human brain that we call neurons. The characteristic of these cells is that their numbers are constant from birth till death.

It is evident how important the breathing air is for a healthy life, as it is calculated that an adult man breathes about 20 m^3 of air per day or 7300 m^3 of air per year. Our brain uses approximately 30% of the oxygen taken into our body. Normally, the brain needs 950 cm^3 of oxygen per minute. If our brain is left without oxygen for a very short time or the oxygen need is inadequate, it may cause irreparable damages. The biggest enemies of our brain and our heart are the hazardous substances like cigarettes, alcohol, drugs and heavy metals. Such hazardous substances cause our body, especially our brain, to become oxygen-free, causing veins to become blocked and cells to be destroyed.

If all the veins surrounding our bodies are to be added end to end, it will reach 150 thousand km, in other words 4 times the length of the earth's periphery. The amount of blood entering and leaving our heart in a day is around 15 tons.

Normal speed of the blood in our vessels is 60 km/h and the blood complete the course of the vessels with this speed in 2 minutes. If the veins are blocked, the heart is abnormally stressed. Carbon dioxide and oxygen change in the lungs takes place in milliseconds. Sodium and potassium ions are pumped into brain cells 300 times per second. Our tissues take oxygen from the hemoglobin in clean blood in such a short time that red blood turns into black blood in a few seconds. It is crucial for our life to have clean, vivid and fluid blood and not to lose its normal healthy state with our other organs.

Every day there are about ten thousand free radical attacks on our cells. If the body is in poor condition and under stress, the effects of these attacks increase by a factor of 10. Hazardous substances entering in our vessels through malnutrition, various additives and polluted environment can cause destruction. All of these attacks come from the weakest points of our body, causing Cancer, Cardiovascular Diseases, Diabetes, Alzheimer, Brain Diseases, Obesity, Poisoning, Early Dementia and various Psychological Disorders.

So, it is obvious how important all the elements that enter our body are important to us. It is very important that a person who is at peace with himself, who is paying attention to body and mental health, should pay attention to all kinds of beneficial and hazardous substances that enter his body. For this reason, people should protect themselves from environmental harmful effects, eat regularly and properly, take great care to their health. Even if some of the hazardous substances have entered our bodies without being aware of them or because of our habits, when these habits are abandoned, our chance to regain our former health by making use of our body's ability to constantly renew itself increases. But permanent changes taking place when bad habits kept persistently destroy brain and cardiac cells, will considerably affect human health and quality of life.

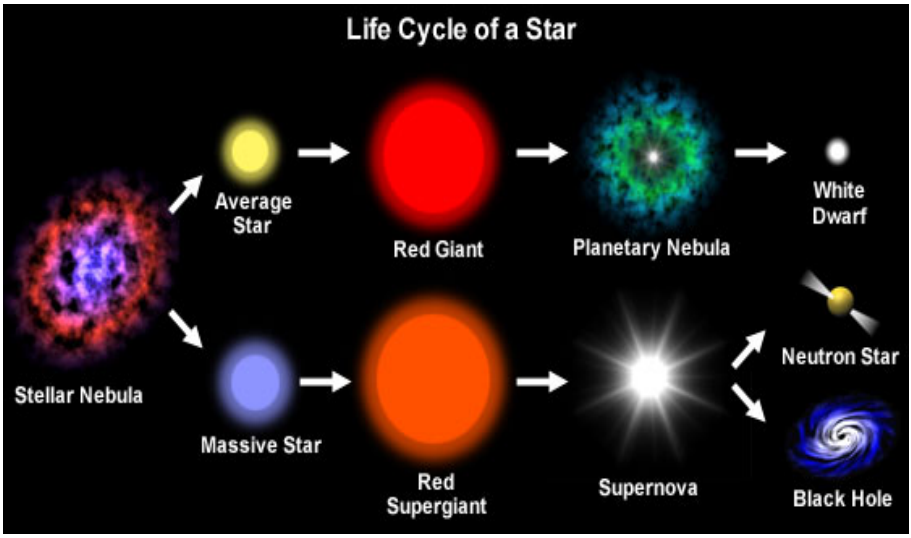
It should not be forgotten that the most important thing that cannot be replaced after being lost in life is the human health. With the statement of **"Health is better than wealth"**, Suleyman the Magnificent nicely expressed the importance of health. It does not matter for a person who has lost his health has million dollars or the whole world. For this reason, we should take care of our health and protect it in the best way.

In this book, essential and vital elements, metal ions, filling, implant and prosthesis materials, additives and hazardous metals for our health presented in detail and a plain language for the first time under the title of **Metallurgy in Our Body**.

ORIGIN OF ELEMENTS IN OUR BODY

Everything around us, including all living beings, things, people, animals, plants, earth, air, the materials we use, planets and stars, consists of the building blocks of elements called "atom".

Well, what is the origin of the atoms, which are the building blocks of everything?



Most of the elements in our body were formed 13.7 billion years ago just after the Big Bang. Hydrogen, which is the most common element in the universe, also forms the greatest number of atoms in our body. Hydrogen, which constitutes about 90% of the universe and about 62% of the body, is the simplest element consisting of only one proton and one electron.

Approximately 62% of the atoms forming our body are Hydrogen, 24% Oxygen, 12% Carbon and 1% Nitrogen. It is estimated that all of these atoms are formed shortly after the Big Bang and the rest are formed in the first stars.

So, what is the remaining 1%? Although the ratio may seem small, these are not the kind of atoms we can give up. Most of these atoms are essential building blocks for our life. Even if these atoms constitute 1% of the total, they make up the large part of our weight because their masses are much larger than the hydrogen.

Most of the known part of the energy in the universe is formed in the stars by transformation from Hydrogen to Helium due to the fusion. Immediately after this great heat after Big Bang, the atoms of "Hydrogen", "Helium", and "Lithium", which have the simplest structure, have begun to form first. In the long period after the formation of the first atoms and elements, the universe continued to expand and cool, and when it had cooled enough, the gases concentrated with the effect of gravitation and began to form different celestial bodies. All the elements except Hydrogen, Helium and trace amount of Lithium present in the universe were produced during the thermonuclear reactions and supernova explosions which took place in the nucleus of the stars after the formation of the stars.

The density, pressure and temperature rise in the nucleus of the star cause Helium to fusion-react and then begin to transform to Carbon and Oxygen. Nitrogen, a lighter element than oxygen, also forms in the nucleus of stars, but the Carbon-Nitrogen-Oxygen cycle forms as a result of a series of reactions. It is thought that the vast majority of the Nitrogen in the universe is formed by these cycles in the stars. In the last stages of their evolution, these stars scattered the various elements including Nitrogen, with strong star winds. As a result of these studies, it is understood that Carbon, Nitrogen and Oxygen are produced abundantly in the universe.

In the nuclei of stars with higher masses from the Sun, the formation cycle of Silicon, Sulfur and Nickel continued in a similar way. The formation of Nickel and Iron also occurs in this way. The production of all the elements that come after the Iron takes place in a single way in the universe, with the conditions that the supernova explosions reveal. Since the pressure and heat arising from these explosions are very high, heavy elements other than hydrogen and helium have begun to form in this way for the first time, thus new elements were added to the periodic table.

Molybdenum, for example, Molybdenum, for example, is an element that we need in order for our body to fulfill its various functions, even though it forms a very small amount of the Solar System. Magnesium is formed as a result of fusion of Neon and Helium in larger stars with higher pressure and temperature in their nuclei. Magnesium is found in trace amount in our body, but it is essential and important element for our body in order to actualize protein synthesis, contraction of the muscles and communication between the nerves.

The formation of heavy nuclei is called a "slow process". And these elements are called "slow process elements". In this process, the stars, of which nucleus intense nucleation-neutron fusion and beta decay

takes place, transforms a portion of the iron in their nuclei into Molybdenum element, which is necessary for the functioning of our body. Here, we can solve how the elements creating life come into being, what is happening in the stars only through researches.

Well, how come the materials in the nuclei of these giant celestial bodies, which are millions of kilometers in diameter, are spread all over the world?

The heat inside the stars is transmitted to the outer layers with the radiation as well as the turbulence. In other words, the materials forming the stars are always in motion. Thus, new elements created in and around the nucleus can reach up to the top layers of the star. When a star completes its life, scatters its top layers. These materials expand in the form of planetesimal cloud and are transported far from the star.

Almost all of Molybdenum, Strontium, Yttrium, Barium, Lanthanum, Cerium and Lead are formed in the stars, during slow processes. Our solar system has also come from the explosions of these stars and these elements have entered the life of all living beings. These elements, formed in a star, meet all the requirements of our bodies. For example, we cannot live a healthy life without Iodine. This element appeared not in the stars, but in the very powerful explosions known as supernova explosions.

In Supernova formed by the explosion of very massive stars, atomic nuclei are subjected to very heavy bombardment by neutrons. As a result of these reactions, the elements we call precious metals such as Silver, Gold and Platinum, as well as the above-mentioned Iodine are revealed. In addition, at the end of the "fast process", there are many light elements, also called biologically important fast process elements. Calcium, Magnesium, Silicon, Sulfur and Titanium are some of these elements.

And it is not known exactly in which processes reveal certain elements. For example, Selenium can reveal in both processes. It is believed that about two-thirds of Selenium, which is required for a healthy immune system, revealed in fast processes, while the rest revealed in slow processes.

According to the theories developed by considering the elements in the world and the abundance of these elements, our solar system consists of the remains of a star that has completed its life.

As a result, in the light of the information we have, it is understood that a part of the elements that make up our body is formed during Big Bang, a part of which is formed by thermonuclear reactions in the stars, and the remainder during the supernova explosions.

METALLURGY IN OUR BODY

Metal elements are essential building blocks that enable the living beings to maintain their healthy life. There are many metal elements in the human body. It is possible to separate these elements into two groups, which are useful and harmful to health. While taking the minerals and metal ions that our bodies need less than the required amount leads to the significant disorders, excessive intake causes various diseases and poisoning. The body's daily mineral needs are met with foods and water. Malnutrition causes the essential elements of the body not to be taken in sufficient quantities. In addition, taking alcohol, cigarettes, drugs and other harmful substances from the environment causes some of the necessary elements to be excreted and some of them to bind to various substances and decrease in our bodies, thus leading to various disorders.

Nowadays, environmental pollution, which is reaching great dimensions, harmful metal ions in the careless and unprotected working conditions is taken to the body through respiration, skin, malnutrition. They can build up in body over time and cause various diseases, poisoning and death. Metals such as Arsenic, Antimony, Lead, Mercury, Cadmium are toxic and cause various diseases and poisoning, even when they are taken into body at very low amounts.

While these toxic elements are present in food, air and beverages in very small amounts, their effects are increasing as a result of industrialization and environmental pollution. This phenomenon, called Chemical contamination, consists of many different sources. For this reason, products can be exposed to involvement of various metal compounds depending on the nature, soil, fertilization and industrial pollution or during storage, packaging, processing etc.

In addition, people nowadays use a wide variety of medicines, vitamin and mineral tablets unconsciously and arbitrarily without consulting doctors, and it can do more harm than good. The basic elements in our body are in balance with each other. When it is unbalanced one-sidedly, it may lead to the lack, excess or interference of other elements. For example, excessive intake of zinc as supplement may lead to copper deficiency, excessive amounts of phosphorus intake may lead to increased calcium requirement. In fact, what is most appropriate for a normal person is that the need is naturally met in a balanced nutritional framework.

The purpose of this book is to provide a source of information about what the elements, metal ions work for in the body, which symptoms can reveal in case of deficiencies and excesses and, accordingly, how important it is to take measures on time. It would be better to examine the elements in our body as metals placed in the body as filling, implant and prosthetic material in place of the organs lost their function rather than the elements taken through daily foods and food additives, from the environment.

Irreplaceable and essential elements for human health are oxygen, hydrogen, carbon, nitrogen, calcium, phosphorus, magnesium, potassium, sodium and chlorine. These elements need to be taken in certain amounts every day. Elements such as iron, zinc, copper, manganese, chromium, molybdenum, cobalt, iodine and sulfur are also vital for the human body. The essential elements for our body which are recommended to be taken for a day re summarized in Tables 1, 2 and 3 (1).

Table 1. Some Elements Recommended to be Taken in a Day

	Age	Magnesium (mg)	Iron (mg)	Zinc (mg)	Iodine (mcg)	Selenium (mcg)
Child	0-0.5	40	6	5	40	10
	0.5-2	60	10	5	50	15
	1-3	80	10	10	70	20
	4-6	120	10	10	90	20
Male	7-10	170	10	10	120	30
	11-14	270	12	15	150	40
	15-18	400	12	15	150	50
	19-22	350	10	15	150	70
	23-50	350	10	15	150	70
	50 +	350	10	15	150	70
Female	11-14	280	15	12	150	45
	15-18	300	15	12	150	50
	19-22	280	15	12	150	55
	23-50	280	15	12	150	55
	51 +	280	10	12	150	55
Pregnant		320	30	15	175	65
Breast-feeding		355	15	19	200	75

These elements must be taken in accordance with the amounts in Tables 1 and 2. Excessive intake is also bad for health. The trace elements such as Vanadium, Manganese, Selenium, Silicon, Molybdenum, Chromium, Cobalt, Nickel are found in different proportions in the body but the total amount does not exceed 50 mg. The amounts of other trace elements, which are estimated to be taken safely for health, are given in Table 2 (1).

Although some metals such as Tin, Lithium, and Selenium are present in the human body, their functions are still being examined. All of these elements we mentioned exist in large quantities in nature. A perfectly created mechanism, like the human body, is designed to take advantage of every element found in nature

Table 2. Trace Elements that Should be Taken in a Day

Age	Copper (mg)	Manganese (mg)	Fluorine (mg)	Chromium (mcg)	Molybdenum (mcg)
0-0.5	0.4-0.6	0.3-0.6	0.1-0.5	10-40	15-30
0.5-1	0.6-0.7	0.6-1	0.2-1	20-60	20-40
1-3	0.7-1	1-1.5	0.5-1.5	20-80	25-50
4-6	1-1.5	1.5-2	1-2.5	20-120	30-75
7-10	1-2	2-3	1.5-2.5	50-200	50-150
11 and older	1.5-2.5	2-5	1.5-2.5	50-200	75-250
Adult	1.5-3	2-5	1.5-4	50-200	75-250

All of the elements that exist on earth are naturally present in the foods we take in small or large quantities. Essential elements have to be taken through food in certain quantities for the growth, development and healthy of living beings. The irreplaceable elements found in the body of a normal adult male are given in Table 3 (2).

Table 3. Elements in an Aduld Male Body Weighing 70 Kg

Element	Amount (g)	%
Oxygen (O)	45,500	65
Carbon (C)	12,600	18
Hydrogen (H)	7,000	10
Nitrogen (N)	2,100	3
Calcium (Ca)	1,500 (99% in bones)	2
Phosphorus (P)	700 (80% in bones)	1
Potassium (K)	200	-
Chlorine (Cl)	110	-
Sulfur (S)	105	-
Sodium (Na)	95	-
Magnesium (Mg)	42	-
Iron (Fe)	3-6	-
Zinc (Zn)	2-3	-
Fluorine (F)	0.2-1	-
Copper (Cu)	0.05-0.15	-

As you can see, the most common elements in our body are Oxygen, Carbon, Hydrogen, Nitrogen, Calcium, Phosphorus, Potassium, Chlorine, Sulfur, Sodium, Magnesium, Iron, Zinc, Flor and Copper respectively, according to their weight. These elements are essential building blocks for the human body. The other trace elements that are irreplaceable for human are less in quantity, so they are not included in this table. The importance and quantities of these elements, as well as toxic metals for the body and sources of contamination, will be explained respectively. In adults, minerals constitute an average of 4.35% of body weight, of which about 83% are in bones and the rest are in muscles and other tissues.

About 60% of a human body is water. If the water loss in the cells reaches 20%, it can result in death. Water is of great importance for living things, it is about the properties of the water molecule. As it is understood from this chart, the amounts of hydrogen and oxygen which constitute our bodies are quite high because they are the building blocks of water.

According to their weight, the second most important in our body is carbon. In all organic components, carbon is the basic building element. The substances other than water and inorganic ions in the cell are carbon compounds. Organic carbon compounds make up 90% of all chemical compounds

Then comes the nitrogen, nitrogen (N) element and the other elements, respectively. Nitrogen plays an important role in the catalytic functions of substances such as proteins and nucleic acids, which are genetic information transfer and store. Similar distributions of all these elements apply to our world as well. About 3/4 of our world is covered by the sea and the oceans, namely water (H_2O). The composition of the air we breathe consists of 78% Nitrogen (N_2) and 21% Oxygen (O_2).

The other elements are distributed in the terrestrial area we live on by showing regional differences. For this reason, different plants grow in various climatic regions and they carry the properties and elements of the soil in the area where they grow. Thus, the elements contained in each plant species differ. Plants of the same species may contain elements in different amounts depending on the nature of the soil in different regions.

From this, it can be easily understood that all living beings are in harmony with the earth we live in. All living beings, similarly bear the same characteristics of the environment they are in.

The vast majority of plants or natural beings are nutrients for other living beings and people living in the same region. These nutrients contain more or less elements necessary for our bodies in accordance with the nature of the environment in which they come from. If the food comes from a polluted environment, they can also carry toxic substances. In order to be healthy, one should pay attention to the environment he lives and works, and to eat properly.

In this book, necessary and harmful metal elements for our bodies, prosthesis and implant materials have been examined in the light of recent study in four parts as:

1. Necessary and İrreplaceable elements for our body,
2. Harmful heavy metals for our body,
3. The materials which can be used as filler, implant and prosthesis in our body, and
4. Food additives and elements taken in our body.

1. 1. NECESSARY AND IRREPLACEABLE ELEMENTS FOR OUR BODY

1.1 Calcium (Ca)

1.1.1 Importance of Calcium

Calcium is one of the elements that our body needs most. In the body of an average person weighing 70 kg, there is 1700 grams of calcium (1, 3). 99% of the total calcium in the body is in bones and teeth. The other 1% is as solution in our body and is used in various biochemical functions. Calcium is bound to a protein called Troponin-C in the muscles. Thus, our muscles can move. Muscles cannot work without calcium. Calcium balance in our body is extremely important for health. It is required for bone resistance and proper work of heart.

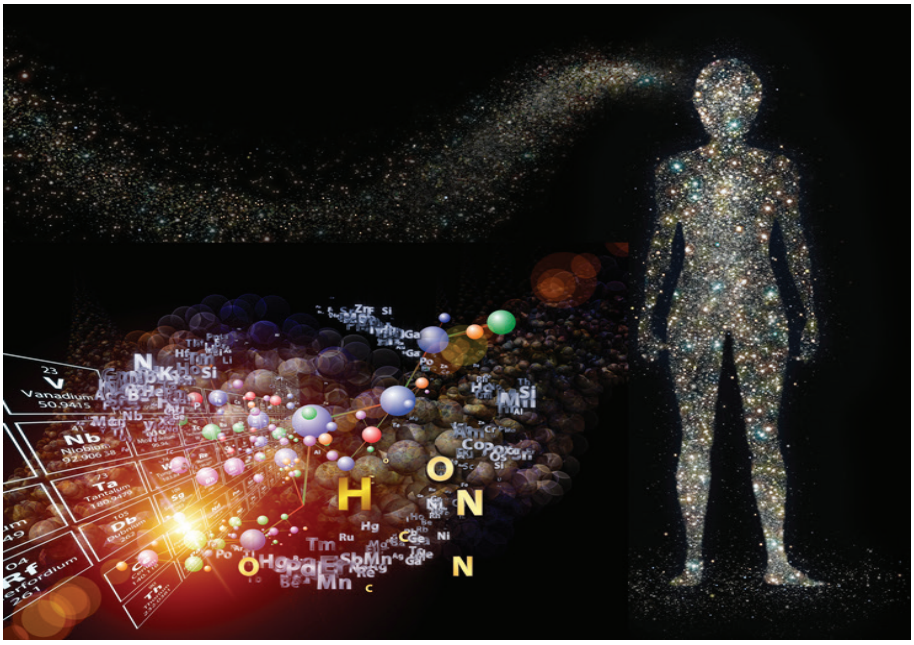
There are 8.8-10.4 mg of calcium in 100 milliliters of the blood of a healthy human. 50% of this is ionized, 45% is bound to protein and 5% is bound to phosphate, bicarbonate or citrate.

The serum calcium level should be 2.20-2.58 mmol/L as reference or the normal calcium level should be between 8.8-10.8 mg/dL. Calcium balance of the body is regulated by parathyroid glands and vitamin D (4).

The amount of calcium to be taken per day was reported to be 500 mg for children, 800-900 mg for adults and 700 mg for the elders (FAO / WHO).

Preservation of the body's calcium balance is of paramount importance during pregnancy, breastfeeding and menopause, when the risk of osteoporosis increases. During this period, the amount of daily intake for a woman can reach up to 1500 milligrams. These amounts to be taken are very important for bone development and body health. Vitamin D in the body affects the amount of protein, the amount of acid, the amount of phosphorus and magnesium, the calcium absorption and the ratio. In order for calcium to function in the body, the ratio of calcium to phosphorus should be 2/1. A diet lacking enough magnesium and vitamin D reduces calcium absorption and disrupts calcium metabolism (2,5).

Figure 1. Elements in Our Body



Sufficient absorption of calcium is possible with a healthy stomach and enough hydrochloric acid secretion. The hormones that affect the calcium balance are complex and interdependent. The most important hormone related to calcium is parathyroid hormone. This hormone increases the activity of vitamin D in the body, increases calcium absorption and helps to remove the phosphorus from the body through the kidneys. In addition, it increases calcium deposition in veins, hair, muscle and joint spaces.

Lack of calcium and vitamin D appeared to increase the absorption of toxic metals such as lead and aluminum in gastro-intestine. Aluminum also destroys the calcium balance because it has a negative effect on the functioning of the parathyroid gland.

Both aluminum and lead have harmful effects on the central nervous system of the body. People exposed to lead and aluminum poisoning need calcium as supplement.

Because the heart is also a muscle, it is very much affected by calcium deficiency. In addition, excess secretion of the parathyroid hormone leads to an increase in the amount of calcium. In this case, the brain is also affected and the person has symptoms of mental disorder, bone pain, frequent renal calculi, muscle weakness, renal calcification, excess calcification and formation of cysts in the bones, abdominal pain and constipation (6).

1.1.2 Absorption of Calcium

Mental status of human affects the calcium absorption of the body to a great extent as it is in all the elements. It is reported in a study that a person with normal calcium absorption suffers about 40% loss of absorption while in a sad and stressed situation. Factors that facilitate and complicate absorption are given in Table 4 (2,7).

Table 4. Factors Affecting Calcium Absorption

Factors Facilitating Absorption	Factors Complicating Absorption
1-The effect of acid reaction at the upper part of small intestine, lactose, citric acid and some amino acids	1- Alkali reaction at the upper part of the small intestine
2- Bile acids	2- Toxic metals and excess of zinc
3- Properness of Calcium/Phosphorus balance	3- Calcium/Phosphorus imbalance, Excessive intake of Zinc and Aluminum
4- Vitamin D	4- Excessively sedimented food
5- Normal movement of small intestine	5- Sadness, distress and menopause period
6- The presence of fatty acids	6- Digestive disorders
7- Presence of calcium binding protein	7- Alcohol and cigarettes
8- Presence of magnesium	8- Redundance of body acids

1.1.3 Diseases Caused by Calcium Deficiency

Calcium deficiency causes especially **rachitism** as a result of weakness of bones and teeth, bone loss called osteoporosis **osteoporosis** at later ages, tooth decay, mental disorders, joint pains with vitamin D deficiency, arthritis, muscular contraction seizures called **tetany, eczema,** tachycardia, hypertension and bone weakness. Breaks in hair and

nails may occur (2). It is reported that calcium balance of the majority of psychiatric patients is unfavorable. The most common mental disorders are depression, panic, nervous tics, insomnia, anxiety and hyperactivity. Improvements have been observed with calcium therapy in people with these conditions. Dietary calcium deficiency also causes more fat accumulation and obesity in the body (6).

1.1.4 Calcium-Rich Foods

Milk, yogurt, cheese, egg, legumes (beans, chickpeas etc.), green leafy vegetables, onion, grapes, fig, spinach, leek, strawberry, potato, hazelnuts, peanuts, almond, fishbone, dried fruits and molasses are calcium-rich (7).

Table 5. Calcium-Rich Foods

Food Groups	Calcium (mg/100g)
Molasses	400
Kashar Cheese	330
Feta Cheese	200
Milk or Yogurt	120
Legume	100
Leaf Lettuce	80
Egg	52
Rice, Pasta	17
Fresh Fruits	15
Meat Products	2

Figure 2. Calcium-Rich Foods

1.2 Phosphorus (P)

1.2.1 Importance of Phosphor

It is the most abundant element in the body with calcium and is a bone-friendly element that participates in functions with Calcium. Like calcium, it is effective in the formation of bones and teeth. Phosphorus is very necessary for all the cells of our body and plays a role in the production, storage and disposal of the energy in our bodies as ATP (Adenosine triphosphate) compound. The level of inorganic phosphorus in the serum is around 3-4 mg/dL (7).

Phosphorus requirement of our body is 250 mg for infants up to 1 year of age and 800 mg for children up to 10 years. The period between the ages of 11-24 is when phosphorus is required the most. At these ages, up to 1200 milligrams of phosphorus should be taken per day. For adults over 24 years old, it is enough to take an average of 800 mg phosphorus per day. Excessive amounts of phosphorus will reduce the absorption of calcium and magnesium, leading to the lack of these two elements. Thus, calcium and magnesium requirement increase.

The ideal calcium/phosphorus ratio should be 2/1. As phosphorus is usually found in abundant amounts in foods, phosphorus deficiency is rarely seen. The problem it would cause in the body occurs when it is taken in higher quantities than calcium and magnesium. B-complex

vitamins are effective when taken together with phosphate. The excess of phosphorus causes a decrease in bone density and strength. As a result, the bones lose their resistance and break easily. In addition, the excess of Phosphorus also increases blood pressure.

The major causes of low levels of phosphorus are alcoholism, continuous use of diuretic, antacid drugs used for gastric ulcer, glucose, vitamin D deficiency, intestinal malabsorption, and pregnancy. (2,4,5).

1.2.2 Absorption of Phosphorus

When phosphorus and calcium are taken in equal amounts, the absorption is high. With vitamin D, absorption is even easier. Aluminium prevents the absorption of phosphorus. In children and adults, 50-70% of the phosphorus in the diet is absorbed. In babies, 85% of the phosphorus in the human milk and 65-70% of the cow's milk are absorbed (7).

1.2.3 Disorders Caused by Phosphorus Deficiency

Phosphorus deficiency causes muscle weakness, disruptions in the neuromuscular system, deterioration of brain functions, infection, failure of white blood cells to function and reduced resistance of body to diseases (4).

1.2.4 Phosphorus-Rich Foods

Milk and dairy products, seafood, poultry, egg, grains, meat, hazelnut, peanut and legumes, cabbage, spinach, onion, garlic, lettuce, apple, grapes, carrot, leek, plum, tomato, cucumber, chestnut, walnut, almond are phosphorus-rich (7).

Figure 3. Legumes are Very Rich in Phosphorus

1.3 Potassium (K)

1.3.1 Importance of Potassium

It is abundant in body cells and less in blood and interstitial fluid. The ratio of potassium/sodium in the cells is around 10/1, and outside cells is about 1/28. Studies have reported that the daily potassium requirement is 600 mg in babies up to 1 year of age. In children up to 10 years of age, the potassium requirement ranges from 1000 to 2000 mg. The amount of potassium that a person weighing 75 kg should have in his body is around 250 grams (1). In adults, the daily potassium requirement is 2000-3000 mg. The kidneys regulate the Potassium/ Sodium balance and help to keep the level of potassium in blood not too high. Potassium is especially important for heart, muscles and nervous system to work. It helps to maintain the normal glucose level in the blood. Increased level of potassium in blood may be seen in case of reduced urine levels, depending on factors such as kidney diseases, ambustions, and bleeding. Apart from kidney and adrenal gland diseases, the causes of potassium loss are excessive diarrhea, vomiting and long-term use of diuretic drugs, long-term laxative therapy, chronic diarrhea, excessive salt, poor intestinal absorption, diabetic acidosis and some gastro-intestinal diseases (4).

Rheumatism and **joint pain** are very rarely seen in China and Japan. The reason is that a lot of potassium-rich rice is consumed in daily food (6).

1.3.2 Disorders Caused by Potassium Deficiency

The main symptoms of potassium deficiency are fatigue, loss of appetite, mental weakness, depression, muscle weakness, irregular heartbeat and muscle cramps. In some cases, prostration, nervousness, swelling of the tissues, joint pain and a rapid heartbeat can also be seen. It should be known that the most important reasons for injuries of athletes are magnesium and potassium deficiency. Inadequate potassium intake can also lead to increased tension. For this reason, it is recommended to people with high blood pressure to eat potassium-rich fruits and vegetables and use cooking methods like steaming or pouching with very little salt or without salt, which do not lead to potassium loss.

Taking potassium in excess (18000 mg a day), ie 3-5 times the required amount, can lead to heart failure. In case of kidney failure,

increased body water depletion, and severe adrenal insufficiency, the amount of potassium in blood can increase up to toxic levels (2,4).

1.3.3 Potassium-Rich Foods

Coffee, fresh fruits, vegetables and unglazed grains, rice, peas, bean, lentil, molasses, dried grapes, hazelnut, chestnut, walnut and almond, liver and chicken are very rich in potassium (7).

Table 6. Amount of Potassium in Some Foods

Food	Amount of Potassium (mg/100g)
Ground Coffee	3000-3250
Legumes	800-1200
Lettuce	800-825
Parsley	725-750
Spinach	660-680
Liver	450-460
Chicken and other meats	300-375

1.4 Sodium (Na)

1.4.1 Importance of Sodium

Normal adult human body has 70-115 grams of sodium. The amount to be taken daily is between 2 and 5 grams (2,5). Most of the sodium is out of the cell in contrast to potassium.

The density difference inside and outside the cell membrane is protected by a biological mechanism called **"Sodium Pump"**. This mechanism pumps sodium out of the cell. Sodium is closely related to body fluid balance and blood pressure. As the amount of sodium in the blood increases, the blood pressure will increase. Excessive amount of sodium causes to increase blood pressure, and sodium deficiency causes to drop blood pressure. This is the reason of drinking salty ayran when blood drops. Sodium is taken to the body as table salt. Salt is also used to protect foods such as meat, cheese, flour and so on. So, our body constantly takes salt and stores some of it. Sodium taken by food and sodium taken by the kidney are in balance throughout the body, depending on the amount. Excessive sweating leads to sodium loss.

1.4.2 Disorders Caused by Sodium Deficiency

The main symptoms of sodium deficiency are nausea, vomiting, dizziness, cramps, prostration, dryness of mouth, hypotension, circulatory disorder, palpitation and shock. Many of these situations are eliminated by salt supplement.

Normally the excess of sodium is removed from the body by urination and sweating. However, the excess of sodium causes hypertension, loss of potassium, water retention and oedema in the body. Harmful consequences of potassium deficiency should be tried to prevent by taking potassium supplement in case of excess of sodium.

1.4.3 Sodium-Rich Foods

Baking soda, dill, pickled olives, cheese, bread, organ meat, egg, green bean, chestnut, apricot, lentil, spinach, cabbage, leek, carrot, lettuce, onion are rich in sodium (4,7).

1.4.4 Monosodium Glutamate-MSG

It helps the taste of your food to be perceived as delicious by the brain when it is added to the food. No matter it is sweet, salty or bitter. It gives flavour to any food. That is why most food producers use MSG for commercial purposes, which causes diseases of our era.

This substance has a **neurotoxic** effect. It damages the nerve cells. Central nervous system damage and in connection with that **Alzheimer, Parkinson, Huntington diseases, epilepsy**, retinal layer damage, fat accumulation, satiety mechanism disorder, obesity, suppression of growth hormone, pancreatic damage, insulin increase and related diabetes, serious damages in kidneys and liver can reveal. This substance can especially damage to the baby on the mother's womb in pregnancy.

This substance is found in many products such as chips, ready-made meatballs mixes, bouillon cubes, instant soup, ice-cream, colourful yogurt etc. which our children and even the adults like and consume very much (6)

1.5 Magnesium (Mg)

1.5.1 Importance of Magnesium

It is one of the most common elements in the cells and is second rank after potassium in this respect. There are 20 to 42 grams of magnesium in an adult person. Approximately 60% of this amount is collected in bones and teeth, 20% in muscles, 19% in cells and 1% in other cellular fluids (3,4). Also known as anti-stress element. It plays an important role in activating enzymes and converting sugar to energy. It allows healthy growth of the body glands and regulates the central nervous system. It is responsible for 80% of all physical activity (3).

It is enough for adults to take 300-400 mg of magnesium per day. This amount can be increased when too much calcium, phosphorus, vitamin D and protein are taken. It can reach up to 600 mg for women during pregnancy and breastfeeding periods. Magnesium is absorbed in the small intestine. Vitamin D improves magnesium absorption. Excess calcium intake reduces magnesium absorption. Approximately 70% of magnesium taken in body is removed by stool, while the rest is removed in the urine (4).

The passage of magnesium through the cell membrane is related to calcium and phosphorus metabolism. Magnesium is required for many metabolic processes, especially for cellular pumps that provide proper passage of sodium, potassium and calcium through the cell membrane. Magnesium allows more than 300 enzymes in the body to function. For this reason, magnesium deficiency affects enzyme systems and reveals metabolic consequences.

Calcitonin and parathyroid hormones regulate the accumulation of calcium in the bones. Magnesium activates calcitonin by suppressing parathyroid hormone. Thus, it allows calcium to accumulate in the bones and be removed from the soft tissues. It also increases the absorption of calcium in foods and prevents bone loss due to calcium loss. If calcium deposition increases in soft tissues due to magnesium deficiency, muscle and joint pains may occur. In such bone and joint disorders, drugs with magnesium are given. The symptoms of Mg deficiency above are similar to those of vitamins B1 and B6.
Because magnesium is required for vitamin B1 metabolism, magnesium is used in combination with vitamins B1 and B6 vitamins in such complaints. Magnesium deficiency can lead to cardiac problems such as coronary spasm, over-stimulation of the cardiac muscle, disorders in the heart rhythm.

Magnesium diet has been reported to be good for depression and attention deficit (6).

Mg deficiency is seen when high-dose or long-term diuretic drugs are used, and alcohol or foods with small amount of Mg is taken. Mg deficiency can be understood from the complaints given above. One of the many reasons for the formation of oxalic acid in the urine and the formation of oxalate stones in the kidneys is Mg deficiency. Taking Mg and vitamin B_6 has shown to prevent the formation of such stones.

1.5.2 Disorders Caused by Magnesium Deficiency

Loss of appetite, nausea, fatigue, prostration, numbness, difficulty in learning, dysmnesia, attention deficit, anxiety, depression, stress, dizziness, headache, blackout, epileptic seizures, muscle cramps, shivering, sudden saltatory, spasms, insomnia, constipation, cardiac rhythm disorders, tongue shivering, blepharospasms, hyperactivity, behavioural disorders, muscle weakness, **hypoglycaemia**, changes in cardiac function and electrocardiogram happens in magnesium deficiency. It is recommended to take 100 mg of magnesium citrate in children and 300 mg of magnesium citrate per day for adults in case of a deficiency (8)

1.5.3 Disorders Caused by Excessive Magnesium

Excessive dosing or accidental intake of magnesium causes signs of **hypermagnesemia** symptoms. Especially in patients with renal insufficiency, it occurs with excess magnesium drugs given for digestive system treatment. In this case, the patient's muscle reflexes disappeared, abnormalities in cardiac electrode are seen, respiration and circulation fail, shock, and even death can occur (2).

1.5.4 Magnesium-Rich Foods

Figure 4. The darker green the vegetables are, the richer in magnesium they are.

Walnut, almond, hazelnut, chestnut, shrimp, soybean, green leafy vegetables, red beet, spinach, potato, carrot, cherries, pear, apricot, unglazed grains, hard tap water, soda are rich in magnesium. The darker green the vegetables are, the richer in magnesium they are, because magnesium is in the structure of chlorophyll in plants (7).

Table 7. Amount of Magnesium in Some Foods

Food	Magnesium (mg/100g)
Bread, Flour	78
Rice, Pasta	33
Legume	166
Meat Products	20
Milk, Yogurt	13
Feta Cheese	33
Egg	12
Spinach	80
Potato	22
Orange	17
Apple	6
Almond, Peanut	280
Dried Apricot	62

1.5.5 Reference Body Analyses

The reference serum magnesium level in a normal human is indicated as 0.80-1.20 mmol/L, .6-2.1 milliequivalents (mEq) per liter of blood, and 800-1100 micrograms/gram of reference magnesium in the muscles (2).

1.6 Iron (Fe)

1.6.1 Importance of Iron

Iron is one of the most important elements of the body. It is building block of hemoglobin, which carries oxygen in blood and myoglobin, which is muscle protein in muscles, as well as being very necessary for various cell enzymes. It is reported that today there are about 2.5 billion people in the world with iron deficiency (4).

In a normal person, the total amount of iron varies from 3 to 6 grams, depending on body size and haemoglobin level. 60-70% of this amount is found in blood cells (haemoglobin structure), 10-12% in myoglobin and enzymes, 15-30% in liver, spleen and bone marrow (2,7).

There is an average of 4-5 grams of iron in an adult male and 3-4 grams of iron in an adult female (1,11).

The amount of iron to be taken in a day is reported to be 10-15 mg for an adult human (1). The red cells in blood undertook the transport of oxygen to the tissues via the haemoglobin in them. Iron coming to the plasma is transported to the bone marrow within 1-2 hours. Normally 90% of the iron absorbed into the blood passes to the bone marrow. It is very important for the function of this molecule that the iron in the haemoglobin remains bivalent. In every cell, it is understood that the iron in our body is very important for life because of the presence of haemoglobin and some enzymes that provide oxygen to our cells. Red blood cells renew themselves every 4 months. The levels required in blood analyses are given in Table 8 (7,9).

Table 8. Normal Blood Analyses

	Hb (g/dl)	Hct (%)	KK (x 10^6 /mm^3)
Adult male	13	45	5
Adult female	12.5	40	4.5

Note: KK: red blood cell at 1mm^3, Hct: percentage of red blood cell, Hb: haemoglobin at 100 ml blood.

The amount of iron removed from the body every day in various ways is between 0.5-1.0 mg. Iron is removed by stool, bile, urine, sweat and skin spillage. The amount lost in an adult male can be replaced by taking 0.5-1.0 mg of iron. In females, iron requirement increases during menstruation and pregnancy. The average loss is around 0.5 mg. For the iron balance to be provided, it is necessary for women to mix 0.7-2.0 mg of iron with blood per day. The need for iron increases during pregnancy, fast growing periods in children, and in adults. The amount of iron that should be mixed with blood daily is 2.0-4.8 mg in pregnancy, 1.0-1.5 mg in infants and children, and 1.5 mg in adults. For this reason, women who are menstruating, pregnant women, children in the age of growth should be fed more iron-rich foods (4,7).

1.6.2 Absorption of Iron

There is a special mechanism that controls the absorption of iron through the intestine surface. Ferritin in the intestine cells regulates the absorption. Iron is found in most of the foods in ionic form with +2 and +3 valences. Trivalent iron cannot be absorbed and have to be reduced. The absorption of iron found in foods shows differences in the body. For example, iron absorption in meat and fish is 15-25%, in liver, 15-20%, in soybeans, 8-10%, in egg 8-10%, in wheat 5%, in spinach 5-10%, in rice 1.5% and 1-5% of the iron in other food can be absorbed. If 15 mg of iron is taken daily with a normal diet, only 0.5-1.5 mg will be mixed with blood. 30% of iron is accumulated in the liver, 30% is accumulated in the bone marrow, and the rest - in spleen and muscles (7,10,11).

Studies have shown that vitamin C taken with foods (vegetables and fruit) increases iron absorption. When 30 grams of meat or about 50 mg of ascorbic acid is added to the food consisting of plant foods, iron absorption is 2-3 times higher. Iron absorption is reduced by oxalates, phosphates, undigested carbohydrates, the way of nutrition such as inadequate meat intake. Abundance of sediment in diet, Aluminium, calcium, magnesium, phosphate intake, as well as coffee and tea being drank with meals reduce iron absorption. It is better to take them between meals, not with meals, so that the iron absorption in the medicines does not decrease. Excess iron intake can also lead to poisoning (2,4).

1.6.3 Iron Deficiency Anemia

Anemia (iron deficiency anemia) is seen when the enough amount of iron is not taken by the body. In this disease, the number of blood cells decreases and the amount of haemoglobin decreases. Thus, since the amount of oxygen carried by the blood decreases, the following symptoms will emerge

1.6.4 Causes of Iron Inadequacy Very Frequent in Our Country

Anemia or iron deficiency among women in Turkey in general is fairly common and causes are summarized below (7,12):

- It is common in women who give birth too often, in pregnant and breastfeeding women
- The fact that the nutrition depends more on the grains and using no or little meat in meals,

- Intestinal parasites which are very common because health and hygiene rules are not observed, as these parasites are fed with blood,
- Inclusion of no iron-containing foods in diet,
- Smoking and use of alcohol,
- Have a quick bite of ready-made foods such as fast-food,
- The use of medicines containing antacids and additives containing aluminum, not taking adequate amount of vitamin C during meals, and the drinking too much tea and coffee with meals lead to anemia

1.6.5 Disorders Caused by Iron Deficiency

Iron deficiency causes anemia. Main symptoms of iron deficiency are fatigue, lack of attention, tachycardia, difficulty in learning in children, soil eating habits, developmental and behavioural disorders. In addition, it can lead to complaints such as hair loss, breaks in the hair and nails, spoon nails, scars on the edges of lips, and swallowing difficulties (9).

Excessive iron is also harmful. Excessive iron intake can cause serious problems such as liver cirrhosis, diabetes, cardiac dilatation, arteriosclerosis, premature aging and lipoidosis of cells

1.6.6 Symptoms of Poisoning

Accidental poisoning is more common in children with iron compounds used as medicines. Oral intake of iron compounds in high amunts causes nausea, blue-green vomit, abdominal pain, black diarrhea, metallic taste in mouth, psychological disorders at the beginning of poisoning. Serum iron level has increased excessively. If the body is loaded with excess iron, some of it accumulates in the liver, leading to liver disorders. In the advanced stages, cyanosis, acidosis, oedema and cardiac disorders also occur.

1.6.7 Iron-Rich Foods

Foods like spleen, liver, heart, red meat, egg yolk, molasses, shellfish, legumes, rice, lentil, peas, bean, parsley, arugula, spinach, carrot, onion, leek, potato, apricot, cheery, peach, apple, pear, strawberry, walnut, hazelnut, fig are rich in iron (7).

a   b

c   d

Figure 5. Some of the foods rich in iron
a) liver b) egg yolk c) sea foods d) molasses

Table 9. Iron Values of Some Foods

Food	Amount of Iron (mg/100g)
Molasses	10.0
Tahini	8.8
Liver	8.6
Legumes	7.0
Spinach	3.2
Raisin	3.0
Egg	2.8
Meat	2.3
Dried Apricot	2.2
Rice	1.6
Chicken	1.5
Bread	1.3
Fish	1.1
Potato	0.8
Orange	0.7
Apple	0.4
Milk, Yogurt	0.1

1.6.8 Studies about Iron

In studies conducted with atomic absorption spectrophotometry on 106 adults in our country, the average value of serum iron in males was found to be between 95 and 103 mcg, and between 91 and 98 mcg in females. The normal value is between 50-150 mcg. The values found are among the values in the atomic absorption spectrophotometer (12).

Pica disease, which manifests itself in the form of eating soil, is one of the major health problems in our country. It is seen in rural areas that make up more than half of the population, especially in children and women. It occurs as a habit of eating clay in women, while in the case of children it emerges in the form of eating habit of soil, lime, sand, wall scrap, paint, ash. Those with soil eating habits have iron deficiency and development disorder. This problem, also referred to as **Tayanc-Reimann-Prasad syndrome** has been examined in more detail by researchers and it has been observed that factors such as zinc deficiency, psychological causes, and malabsorption in the body are caused by these habits (also called as **Geofagia disease**) as well as iron deficiency (10 ,12).

Studies have shown that a cup of tea reduces absorption by about 64% in the nutrient intake and a cup of coffee reduces iron absorption by about 40%. For this reason, it is recommended not to drink tea and coffee during meals, to drink at least 1 hour after meals and not to exceed 1-2 cups (2,7,10).

In the studies, it is reported that cigarettes and alcohol also cause anemia. In particular, carbon monoxide in cigarettes takes up the oxygen and causes oxygen deficiency of up to 33% in smokers. It was also observed that the cadmium in cigarette mixes with the blood and is effective on iron (2).

1.7 Zinc (Zn)

1.7.1 Importance of Zinc

Normal adult human body has 2-3 grams of zinc. They are stored in bones, teeth, hair, skin, muscles, prostate, testes and liver. 85% of all blood zinc is in red blood cells. Zinc is found in less than 3% in leukocytes and less than 1% in thrombocytes. The daily requirement for zinc in an adult person is between 12 and 20 mg. Only about 20-30% of the zinc taken from foods is absorbed and mixed with the blood.

Breastfed new-borns require 0.7-5.0 mg of zinc. It is estimated that children usually receive 0.2-0.4 mg/kg zinc per day (2,12).

Approximately 6.6 mg of zinc taken with daily foods in a normal human remains in the body, about 5.6 mg is removed by stool and 1 mg is removed by urine. Zinc is removed from the body also by sweat. In warm climates it is stated that 2-3 mg of zinc per day may be lost by sweat. Zinc is found in the serum bound to proteins (12).

It is now well understood that zinc imbalance in the human body causes many disorders. The rate of zinc in the body is closely related to elements such as iron, copper, manganese, selenium. The excess of zinc prevents iron from freeing from ferritin by taking it into its compound. It also affects iron absorption and limits the storage of iron in tissues as ferritin. It has also been observed that there is a relationship between zinc and copper. Excess zinc in diet leads to findings of copper deficiency, including anemia, and it has been shown that this anemia can be prevented by copper intake. Excess amount of zinc prevents copper absorption and can cause copper deficiency disorders. Oral iron medications also affect the zinc absorption of body. High amounts of calcium, phosphorus, iron and copper taken during meals reduce zinc absorption.

Zinc is very important for vitamin A metabolism. The amount of protein also affects zinc absorption and excess protein increases the requirement for zinc. In addition, those who has pancreatic insufficiency, intestinal parasites, those who eat soil, take fiber-rich foods, iron medications, alcoholics, and some elderly people cannot perform adequate zinc absorption even if they eat properly. Zinc requirement increases in pregnant and breastfeeding women, children in growth period, cancer patients, psoriasis patients. It has been observed that only 42% of the daily zinc requirement can be obtained in pregnant and breastfeeding women (1,2,12).

1.7.2 Disorders Caused by Zinc Deficiency

Slow growth in children, inadequacy in development of intelligence, weakening of body's defence system, late sexual maturation, impotence, infertility, oligospermia and hypoactive sexual desire, depression, attention deficit, hair loss, dandruff and skin problems, psychiatric problems, nail problems, white spots on hand nails, behavioural and sleep disorders, frequent and severe infections, slow healing of scars, weakness of connective tissue, glucose intolerance, gastrointestinal disorders are observed in zinc deficiency (2, 4, 5).

Zinc excess may also cause problems such as nausea, vomiting and diarrhea, restlessness, sweating and shivering, and cholesterol imbalance, as well as weakening of the immune system and tumour formation in case of overuse.

1.7.3 Zinc-Rich Foods

Pumpkin seeds, fresh oyster, ginger root, chop, steak, peas, beef liver, egg yolk, soybean, grains, almond, walnut, shrimp, turnip, parsley, potato, garlic, carrot, bean, corn are rich in zinc (7).

1.7.4 Reference Body Analyses

It has been reported that the reference amount of zinc in a healthy adult person is in the range of 70-150 mcg/dl in the plasma. The amount of zinc in blood should not be less than 60 mcg/dL (1).

Table 10. Zinc Values of Some Foods

Food	Zinc (mg/100g)	Food	Zinc (mg/100g)
Wheat	16.7	Meat	2.0
Liver	4.0	Mushroom	1.3
Almond	2.5	White bean	1.0
Cheese	2.4	Fish	0.5
Walnut	2.3	Bread	0.5
Wheat, Bulgur	2.1	Vegetables	0.2-0.4

1.7.5 Some Studies about Zinc

In studies conducted in the UK, all of the patients admitted to the psychiatric clinics were found to have low levels of zinc and magnesium in their plasma. In children with mental deficiency and dirt eating habit, it is observed that the amount of zinc is low and the amount of copper is high in their hair. Hair loss has been detected that animals with zinc deficiency moults. Today, treatment methods have been developed to prevent hair loss with zinc supplements. In some studies, it has been reported that the zinc requirement is increased in case of overuse of medicines such as penicillamine, steroid, ethanol, diuretic, purgative medications (2). In addition, excessive amounts of alcohol, tea and coffee affect zinc metabolism negatively.

In studies conducted with atomic absorption spectrophotometry on 106 adults in our country, the level of serum zinc in males was found to be between 110 -118 mcg, and between 94 and 100 mcg in females. The normal value of serum zinc is between 55-120% mcg. (12).

It has been observed that serum zinc concentration decreases in various diseases. There are 50-60 mcg zinc in every gram of human liver tissue. In patients with advanced cirrhosis, it is seen that serum zinc decreases Leukocyte zinc levels were also found to be low in patients with acute and chronic leukemia. The amount of serum zinc in the majority of patients with bronchial carcinoma is low.

Zinc deficiency has been reported to cause problems, in particular **retarded development** and **hypogonadism** (nondevelopment of sex organs).

It is known that zinc is found in the bone tissue. Zinc distribution in the bones was examined with histochemical dyes and radioactive Zn65, and this element was stated to be a key element for bone calcification.

It has been shown that delayed growth and sexual maturation in humans and healing of scars are compatible with zinc treatment. It has been understood that problems such as **dwarfism**, nondevelopment of sexual organs, hepatosplenomega and splenomegaly in people living in Nile Valley villages in Egypt are due to zinc deficiency. Growth, improvements in sexual organs, liver and spleen have been observed in those who received zinc treatment (7).

Zinc is closely related to protein synthesis, especially RNA activity. As mentioned above, zinc deficiency causes growth retardation in animals and humans. The earliest sign of zinc deficiency is the deterioration of RNA. This is followed by a decrease in DNA and protein synthesis. For this reason, zinc has a relationship with both enzyme activity and protein synthesis.

Zinc plays a role in the effects of hormones, especially the effect of growth hormone, together with manganese, and the importance of zinc, particularly in the age of development has been underlined (1, 4, 12).

Studies have shown that zinc deficiency can be determined by hair analysis. These researchers stated that zinc deficiency is very important for the physical and sexual development of children in particular, and that many diseases that may occur can be avoided with timely treatment.

It has been determined that sperm is the most abundant zinc in the human body and about 1 mg of zinc is removed from the body during an ejaculation.

According to a study in China, it has been detected that 30% of Chinese children have short stature due to zinc deficiency and a significant amount of stretching has been recorded in the length of children treated with zinc.

In our country, especially in rural areas with soil eating habits, zinc deficiency is common in 2-3 years old children and women as well as anemia. It has been reported that soil prevent the absorption of iron and zinc through the intestines and causes deficiency (12).

A study on prisoners conducted in the UK found that the levels of zinc, magnesium, selenium, potassium and iodine in these people's blood were very low. All of these deficiencies together has been seen that they have effects on aggression, anger and inappropriate behaviours (6).

1.8 Copper (Cu)

1.8.1 Importance of Copper

Copper is one of the essential elements for the normal functioning of body metabolism. A normal adult person has between 80 and 150 mg of copper. Approximately 1/6 of this amount is collected in the liver, 1/6 in the brain, 1/3 in the muscles, and the rest is in bones, hair and other parts. The amount of copper in the tissues ranges from 1.5-2.5 mcg/g (1,2,5).

The daily requirement for copper in an adult person is between 1.0-3.0 mg. A person who takes 2 mg of copper per day maintains its metabolism in a normal way. The daily requirement of children and infants is 0.4-0.01 mg/kg. 30% of copper taken by foods is absorbed by the body. In adults, daily absorption is 0.6-1.6 mg. The liver stores the copper. The liver removes excess copper from the body through bile duct. 16% of the copper is removed by stool, 4% by urine, the rest is by bile. Even if the amount of copper supplied with food increases, the level of copper in the body remains constant.

Some of the reasons for reducing copper absorption are excessive intake of zinc and vitamin C, excessive intake of calcium, molybdenum, mercury, lead, cadmium and sulfur, excessive and continuous consumption of raw meat. It has also been found that there is a balance

between copper/zinc elements in the body. For this reason, an excessive increase in zinc in the body will lead to a decrease in the amount of copper and an increase in blood cholesterol. Copper is present as erythrocuprein in erythrocytes. Experimental studies have shown that copper has an effect on iron absorption and that copper is increased in the iron deficiency anemia. In plasma, 95-96% of copper is bound to a protein called ceruloplasmin. Copper also takes place in the structure of various enzymes such as tyrosinase, catalase, uricase, oxidase.

1.8.2 Diorders Caused by Copper Deficiency and Malabsorption

Copper deficiency causes disorders such as anemia, skeletal and nervous system disorders, reduced productivity, immune system disorders, changes in hair colour and structure. Excess copper leads to a significant increase in risk of cancer, as well as serious mental and physical disturbances such as depression, schizophrenia, dementia, and hypertension (2,4,7).

Menkes syndrome: In the case of too much copper deficiency, the kinky hair syndrome known as Menkes is observed. According to clinical determinations, the hair in this early-onset disease is entangled and kinky. There are also differences in skin and hair colour. Bone and nervous system disorders occur.

Wilson's disease : This disease is genetically copper deposition disease and occurs between the ages of 6-40. The disease also includes nervous disorders, liver cirrhosis, green-brown stains in brain, kidney and cornea. Because copper is most commonly collected in these organs. The amount of copper increases in the urine. In this disease, the amount of serum copper is determined by analysing its amount in, ceruloplasmin and urine. In early diagnosis, this disease can be prevented to a large extent.

1.8.3 Copper-Rich Foods

Foods such as liver, kidney, legumes, hazelnut, walnut are rich in copper (7). Copper-rich foods are given in Table 11.

1.8.4 Reference Body Analyses

The amount of reference serum copper is between 118-302 mcg/dL in pregnancy, 80-190 mcg/dL in children, 80-155 mcg/dL in women and 20-70 mcg/dL in infants (1,2).

Table 11. Zinc Values of Some Foods

Food	Zinc (mg/100g)	Food	Zinc (mg/100g)
Dry Yeast	5.0	Raisin	0.3
Liver	3.4	Bread	0.2
Molasses	1.4	Rice	0.2
Meat	0.8	Green Bean	0.2
Fish	0.8	Potato	0.2
Parsley	0.5	Spinach	0.1
Dried Apricot	0.4	Egg	0.1
Olive	0.3	Milk, Cheese	0.03

1.8.5 Some studies about Copper

In hair loss treatment, tablets containing copper are given to regulate the rate of Zinc/Copper. Study has shown that copper plays a role in the production of certain chemical substances in the brain and causes copper causes **schizophrenic** developments. It was observed that when the copper level was lowered by giving vitamin C, zinc, manganese and B group vitamins to these patients, the condition of the patient improved.

In studies conducted with atomic absorption spectrophotometry on 106 adults in our country, serum copper was reported as 147-153 mcg, 128-134 mcg in males and females, respectively. Normal values are 65-145 mcg. In this study, serum copper levels were observed to be above normal in 55.5% of males and 31.1% of females. In these observations, serum copper is thought to increase biologically in young people with emotional and metabolic stress (12).

Experimental studies have shown that copper plays a role in **pigmentation, keratinization,** stability of the nervous system, **osteogenesis,** formation of elastic tissue, **hematopoiesis** and numerous physiological events.

1.8.6 Occupational Diseases and Poisoning

Copper in pure form, is widely used in industry as oxide, carbonate and sulphide compounds. Copper is not toxic in metallic form. But soluble mineral salts such as copper sulphate or copper hydrocarbon lead to poisoning. The maximum value that copper salts can be present as particles in air is limited to **1 mg/m^3**. Poisoning with copper salts occurs via industrial wastes or by oral intake of these salts. In a short time, it reveals itself by blue-green vomit, stool and severe dysenteric effect.

Copper causes liver diseases, since it is a substance that accumulates in the liver. Copper examination in serum is done by atomic absorption method and by measuring ceruloplasmin value. Copper can also pass foods through copper vessels and pipes. If carbonated and acidic foods are kept in copper cups for a long time, too much copper ions are mixed in them. The maximum amount of copper that can be present in beverages should be around **0.3 mg/L** (see Appendix 2).

1.9 Vanadium (V)

1.9.1 Importance of Vanadium

Vanadium is one of the trace elements in the body. An adult human body contains 17-43 mg of vanadium (1). It is recommended to be taken 10-12 mcg per day. It enhances the effect of the insulin hormone of body. This element is concerned with growth and fat metabolism. Its deficiency may cause elevation of blood cholesterol. In studies, it is stated to be beneficial for cardiac diseases, liver functions, strengthening of teeth and bones and intravenous fat accumulation. In addition, vanadium levels have been found to be high in the hair of depressed patients (4).

1.9.2 Vanadium-Rich Foods

Main sources of vanadium are parsley, soybean, wheat, egg, sunflower seeds and oil, oat, carrot, cabbage, plum, garlic, tomato, rice, corn, soy, green bean and oyster (4, 7).

1.9.3 Reference Body Analyses

The amount of vanadium measured in healthy adult humans is 0.02-8 mcg/L for whole blood, 0.1-17.0 ng/mL in erythrocytes, 0.02-1.3 mcg/L in plasma or serum, 0-10 mcg per day in the urine, 0.09-0.16 mcg/g (1, 2) in hair.

1.10 Iodine (I)

1.10.1 Importance of Iodine

It is a very important element for the production of **thyroid** hormone in the human body. Thyroid hormone plays a role in controlling all metabolism.

For this reason, when there is a disorder in the production of thyroid hormone, all the functions in the body are confused. An adult human body contains 20-30 mg of iodine (1). About 80% of the iodine in the body is in the thyroid gland. Iodine taken from foods is used by the thyroid gland in the production of thyroid hormones T3 and T4. If there is not enough iodine in the body, these two hormones cannot be produced. Approximately 30% of iodine absorbed into the blood is taken by the thyroid gland and stored as **"Thyroglobuline"**. The rest is removed by stool and urine. The daily iodine consumption of an adult is between 50-150 mg. The recommended amount is 150 mg per day (1,2,4).

It has been reported that around 200 million people worldwide are suffering from diseases caused by iodine deficiency. About a quarter of the children in the world are at risk of iodine deficiency, one of the main causes of preventable **mental deficiency**. Since the most important source of iodine is seafood, iodine deficiency is seen in people who live far from seas and in the areas and especially in mountain regions, where seafood is not consumed. The **thyroxine** hormone secreted by the thyroid gland is extremely important for the physical and mental development of children and is concerned with the iodine element taken into the body.

As the soil and water in mountain regions contain very little iodine, the foods obtained from these regions are insufficient in terms of iodine. In this case, the thyroid gland, which wants to meet the iodine deficiency, starts to grow to produce enough amount of thyroxine by using more of the existing iodine. Thus, it causes to expand in front of the throat, in other words **Goiter**. Taking excessive amounts of iodine reduces the efficiency of the thyroid gland. Iodine and low amounts of lithium supplement are recommended for those, whose thyroid glands are overactive. Fishermen consuming too much seaweed in a region of Japan have consumed excessive amounts of iodine and have been suffering from goiter disease (4,5)

1.10.2 Iodine-Rich Foods

Seafood, shrimp, whiting, oyster, fish, poultry, meat, liver, garlic, pineapple, egg, peanut, whole wheat, legumes, spinach, pepper, dittander, turnip, cabbage, carrot, tomato, radish, butter, milk and raisins are rich in iodine (7). Iodine-rich foods are given in Table 12.

Table 12. Amount of Iodine in Some Foods

Food	Amount of Iodine (mcg/100 g)
Chicken	50
Fish	30
Egg	27
Spinach	20
Feta Cheese	15
Legume	5.0
Milk	4.0
Meat	3.0
Apple	1.6

1.10.3 Disorders Caused by Iodine Deficiency

Iodine deficiency causes problems such as **mental deficiency**, developmental disorders, physical disorders, deafness, dumbness, **goiter**, fatigue and shivering. **Cretinism** is seen in children given birth by mothers who do not have enough amount of iodine. There are two types of this disease: Neurological and Myxoedemical. In neurological type, mental deficiency, spastic disorder, myolysis, deafness, dumbness, learning difficulty and laziness are observed. And in the other type, laziness, reluctance, learning difficulty and over-weight are observed (7).

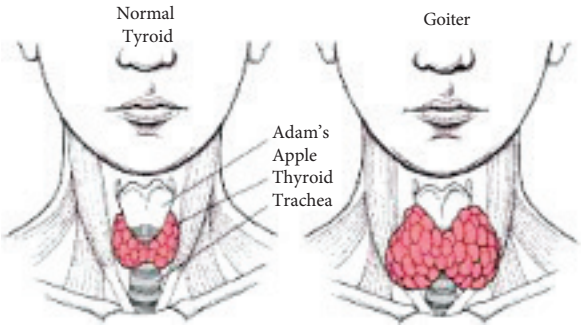


Figure 6. Goiter is Caused by Iodine Deficiency

1.11 Selenium (Se)

1.11.1 Importance of Selenium

Selenium, a powerful and natural antioxidant, is an element that strengthens the immune system and reduces the risk of cancer. It protects the cells and slows down the aging process. It cleans dead

and useless cellular debris and toxic waste. It reduces the side effects of free radicals. It promotes cardiovascular health by increasing tissue flexibility and supporting cardiac cells (3). By entering the structure of the selenoprotein that protects our cells from damage, it protects our immune system and allows the thyroid gland to work better. Selenium was calculated in the researches of amounts of selenium in human body to be approximately 0.44 micrograms in the liver and 0.37 micrograms in the skin and muscles. The highest values have been found in the nails and the kidneys. The average selenium concentration in urine is 0.049 ppm, while the selenium concentration in the nails is 1.14 ppm (15). A healthy human body has selenium in the range of 12-14 mcg. The amount of selenium that adults should take in a day is 70 and 55 micrograms, respectively (Table 1). Excessive amount of intake is also harmful. The ideal amount for a human weighing 80 kg is 80 mcg. These amounts vary according to the geographical regions. For example, the amount of selenium taken per day in the US is between 83-129 mcg. It has been reported that the daily selenium intake in New Zealand and Finland, which is poorer in terms of selenium, is between 28-32 mcg and 30-50 mcg, respectively (16). In some regions of China, the lowest and highest amounts of selenium taken daily has been reported as 10 mcg (microgram) and 6.7 mg (milligram) (14). This difference is due to the fact that the various regions have more or less selenium content in the soil, living and vegetation cover (13,14).

Because the body burns selenium, it is necessary to take enough amount of it every day. The role of selenium in diet revealed after the liver necrosis caused vitamin E deficiency was prevented by trace amount of selenium like 0.5 ppm in the experiments conducted on mice in 1957. All of the diseases related to water retention and hypodermic hemorrhage seen in poultry since 1958 due to vitamin E deficiency have all been solved with selenium supplement. White muscle disease seen in lambs and oxen in New Zealand has been eliminated by selenium treatment. In Scotland, by supplying selenium and vitamin E the sheep fed with deficient selenium, the number of premature and stillborn lambs were reduced. It is known that mice fed with foods added vitamin E but poor in selenium are found to have baldness, cataracts in the eye, vascular disorder and morphologically abnormal spermatozoon (15).

It is also suggested that selenium deficiency may cause cancer and cardiac diseases. Recently it has been reported that glutathione

peroxidase, which protects erythrocytes against the toxic H2O2 (hydrogen peroxide) accumulation, is an enzyme containing selenium, and selenium is a complementary element to this enzyme. In measurements made in calves and lambs, kidney is the first, liver is the second, and muscles are the last in terms of selenium retention.

One of the reasons for the selenium deficiency is the alcohol consumption. Alcohol prevents enough selenium from being taken into the body through the food and causes high amount of selenium removed from the body by urine and stool with the metabolism change. It is also believed that hypersensitivity to chemical substances is associated with selenium deficiency. Selenium is required for the enzyme **glutathione peroxidase**, which catalyses the reduction of H2O2 and the oxidation of a particular element (4).

1.11.2 Disorders Caused by Selenium Deficiency

Selenium deficiency is more common in patients with liver diseases, cancer, and cardiovascular diseases. In patients with selenium deficiency, the malabsorption and disorders of foods mixing with blood as a result of this deficiency is also indicated. Other diseases are cardiomyopathy and various cardiac problems. In addition, complaints such as unpleasant emotional state, acne and eczema have been reported (13,16).

It is known that selenium is good for hair scuffs and some fungal diseases. The selenium ratio is high in selsun shampoos. They have been reported to be effective in the treatment of hair scuffs. Excess selenium can cause problems such as hair loss, breaks in nails, splenomegaly and liver injury.

1.11.3 Selenium-Rich Foods

Selenium is found mostly in fish and seafood. Sea products are followed by meat, mushroom, cereal products, asparagus, egg yolk, red pepper and garlic (4, 7).

1.11.4 Reference Body Analyses

In healthy adults, selenium concentration is reported to be 58-234 mcg/L in whole blood, 75-240 mcg/L in erythrocytes, 46-143 mcg/L in serum or plasma, and 0.2-1.4 mcg/g in the hair (1).

1.11.5 Occupational Diseases and Symptoms of Poisoning

It is used in industry in processing of copper, production of electronics, photograph materials, glass, ceramic and dye. It is not absorbed in the body metallically. But its salts can enter the body through digestion, inhalation and skin. It accumulates more in kidneys, gall bladder, spleen and liver. And it is removed from the body by urine, stool, sweat and milk. Inhalation selenium salts for a long period of time results in corrosion on the tongue, gastrointestinal disorders, discoloration of teeth, hair loss and peeling on nails, sensory impairments and liver disorders.

1.11.6 Some Studies about Selenium

In Keshan region of China, **cardiomyopathy** disease has been very common in children and young women, and studies has shown that the disease is caused by Selenium deficiency. Since the disease was detected in this region, it was called **Keshan Disease**. The daily selenium intake in this region is reported to be less than 10 mcg (14). Finland is the country where deaths due to heart diseases are most common in the world. Studies in this country have reported a relationship between cardiac diseases and low serum selenium levels. The daily selenium intake in this country is 30-50 mcg (7, 13).

Other studies have shown that Selenium deficiency increases cancer risk, and that cancer patients have a lower level of selenium in their urine than normal. Studies on mice have shown that Selenium prevents spontaneous breast cancer and prevents other tumorigenesis (15).

It has been understood that selenium is a very important element for long life. Studies have shown that animals that have never been given selenium have died. In a patient, whose stomach were taken and sustained by gastrogavage for 2 years in New Zealand, have observed the sypmtoms of Keshan disease as no Selenium were given. When the doctors started giving this patient Selenium, they reported that the patient's condition improved gradually (13,14).

Studies have shown that Selenium is abundant in the soil where **people who live long** reside. The country with the people living longest is Japan, whose main food is fish. There are a lot of selenium in the plants under the sea that the fish feed. Concentrated Selenium was calculated 2500 times in phytoplankton. Finland, Poland, England and Belgium have been found to be very poor in terms of selenium (13).

1.12 Silicon (Si)

1.12.1 Importance of Silicon

It has been reported that a healthy person's daily silicon requirement may range from 5-20 mg. It is an important element that provides the flexibility of blood vessels and is effective in the development of hair and nails. The amount taken daily by foods is between 21-46 mg. There is abundant amount of it in many foods, especially in unprocessed cereals (1,4).

Silicon atoms form strong bonds between them. For this reason, the silicon molecules are more stable and more strongly bonded in terms of structure compared to bonds between carbon atoms. Due to this structural feature, there is a large amount of silicon in **structural tissues** such as arteries, sinews, skin, connective tissue, cornea, sclera, hyaline cartilage. But liver, kidney and blood tissues have very little silicon. It has been found that there is 14 times less silicon in arteries with arteriopathy than healthy arteries.

It is thought that there is a relation between arteriosclerosis and the element of silicon. Silicon has been reported to have effects on bone calcification together with Calcium, Magnesium and Fluorine.

Silicon slows down the aging process by having an effect upon immune system, is beneficial to ostheoporosis and Alzheimer's disease (4).

1.12.2 Disorders Caused by Silicon

In studies on animals, it has been reported that silicon deficiency leads to developmental disorders, disorders of hyaline cartilagebone, bone and connective tissue. Excess silicon frequently causes renal calculi with magnesium (4).

Inhalation of silica dust in work places can lead to "Silicosis" lung disease accumulating in the lungs. **"Silikosis"** lung disease by accumulating in the lungs.

1.12.3 Reference Body Analyses

It has been reported that silicon concentration in blood analysis of healthy adults is 1.2-8.9 mcg/L, 4.1 mcg/L in erythrocytes, 0.4-10.0 mcg/L in plasma or serum, 2-10 mcg/kg in muscles, 4.7-5.2 mcg/L in urine (4,7).

1.12.4 Silicon-Rich Foods

Silicon is most commonly found in garlic, apples, green beans, cauliflower, peas and strawberries (4).

1.13 Molybdenum (Mo)

1.13.1 Importance of Molybdenum

An adult human body contains 8-10 mg of molybdenum (1). Much of this has been accumulated in the liver, kidney, adrenal glands, bones and skin. It is found in the structure of the enzymes that enable the formation of uric acid in our bodies. High amounts of molybdenum are retained in the liver. Daily intake of molybdenum ranges from 50 to 350 mcg. It is found in daily foods in between 50-100 mcg. The amount that is seen no harm for healthy adults ranges from 75 to 250 mcg per day, as shown in Table 2 (1,4).

There is an interaction between molybdenum and copper, and if the excess copper is taken with food, the body will remove molybdenum in a very large amount. Molybdenum deficiency has been observed in a patient who has to be fed only by drip-feed for a long period of time and has been reported that these patients have problems such as quick pulse, tachypnea, night blindness, and hyperarousal. In another case, a dam was built in the Nagarjunasagar region of India many years ago, and **bowlegs in the shape of (X)** called as **Genu Valgum**, have been encountered in most of the children who lived in the surrounding villages of this dam. It has been observed that the waters leaking from the dam to the region increased alkaline properties of underground water. The amount of molybdenum entering the body increased with the increase of molybdenum in the pearl millet, which is the main food of the region, and consequently, excessive intake of molybdenum reduced the copper absorption in the intestines. Researchers have reported that the copper deficiency in the body causes the bones to soften, leading the knees of the children to be knocked (knees have closed together in shape of X and feet have moved away from each other). Experts have suggested growing plants containing less molybdenum in this region or watering pearl millets with purified water (17).

1.13.2 Reference Body Analyses

The reference amounts a healthy adult has been reported as follows: 0.8- 3.3 mcg/L in whole blood, 0.1-3.0 mcg/L in serum or plasma, and 20- 490 mcg/kg in hair analysis (1).

1.13.3 Studies about Molybdenum

Copper deficiency has been observed in cattles fed on molybdenum-rich meadows and the disease has been treated with copper supplement. It has been reported that this relationship formed in metabolism as molybdenum is replaced by copper. When excess amount of molybdenum taken, the amount of copper in blood and urine increases, and the amount of copper in the bile and small intestine secretions decreases. Molybdenum deficiency leads problems such as **night blindness**, tachycardia, coma and headache. It has been reported that gastric and oesophageal cancers are more common in China, due to molybdenum deficiency (4). Molybdenum deficiency has been suggested to be associated **throat cancer** seen in Bantu women in South Africa. In Molybdenum deficiency, ***Aspergillus flavus*** mold in corn and other plants increases, and this mold forms cancer-causing molecules (7).

1.13.4 Molybdenum-Rich Foods

Meat, legumes, grains and yeast are rich in molybdenum (4).

1.14 Chromium (Cr)

1.14.1 Importance of Chromium

The reference amounts a healthy adult has been reported as follows: It is one of the trace elements in the body. It has been calculated that the human body has 0.02-0.64 ppm chromium (4). The most chromium-containing organ is the liver. The amount of chromium that should be taken daily for adults varies between 50-200 mcg (Table 2). It is important to control blood sugar. Insulin is required to control blood sugar level and for glucose to enter the cells. It allows for the insulin hormone secreted from the pancreas gland to work well and regulates the blood sugar. Our cells need glucose to produce energy. When the body cannot control the blood sugar, the blood sugar rises and the **diabetes** we know occurs. Hearth attack, stroke, vascular diseases are more likely to have in people with diabetes. It causes damage in the veins, disorders in eyes, kidneys, nerve fibers and skin. Sufficient amount of chromium is required to be taken to maintain insulin activity or normal level of blood sugar. In order for the human body to be able to use chromium, the chromium must be in the form of a molecule of vitamin B3 (Niacin) and three specific amino acids. This is called **Glukose Tolerance Factor**.

The richest glucose tolerance factor in nature is found in brewer yeast. The body absorbs and uses this kind of chromium better. The best absorbed chromium salt in the intestines is Chromium Picolinate (1, 2, 4). Chromium can enter the body in people who are exposed to continuous chromium compounds in the industry. Some of the chromium in the stainless steel used to process foods may dissolve and mix with foods. In people working in chromium plating plants, steel production, chemical industry, photography, leather tanning, etc., chromium can cause a variety of diseases by certain amount of which entering the body. **Chromium ulcer** among these have effects on nails, fingers, hands and arms. Cr^{+6} is prohibited due to environmental pollution and carcinogenic effect.

1.14.2 Disorders Caused by Chromium Deficiency

In people with chromium deficiency, disorders such as **glucose control impairment, decreased insulin activity**, loss of corneal transparency, fat deposit in the arteries, oligospermia, and elevated blood sugar occur. Excess chromium can cause allergic reactions, conjunctivitis, skin diseases, ulcer, oedema, liver inflammation, hepatitis and lung cancer in sensitive structures and other people (4).

1.14.3 Chromium-Rich Foods

Brewer's yeast, black pepper and other species, garlic, liver, meat, stinger, broccoli, oat, wheat, cheat are rich in chromium (4, 7).

1.14.4 Studies about Chromium

Improvement in **glucosis tolerance** factors has been achieved with the daily 150 mcg chromium (III) diet applied to middle aged and elderly people in the United States.

By adding 250 mcg of chromium in the daily diet of badly-nourished children in Turkey and Jordan, there have been positive developments in the glucose tolerance tests. It has been observed that depression decreased with chromium supplement (6).

1.15 Manganese (Mn)

1.15.1 Importance of Manganese

It is one of the trace elements in the body. It plays an important role in healthy bone development, development of the nervous system and increasing the body resistance. It is found in **Superoxide Dismutase (MnSOD)**, and protects ouur body from harmful effects of free

radicals (4, 6). It is found in bones, soft tissues, pituitary gland, pancreas, liver and kidneys in different amounts. In an adult, there is between 12-20 mg of manganese. The amount of manganese that a healthy person can take daily is between 2.0-5.0 milligrams (Table 2).

Taking more than 10 mg of manganese orally in a day is not safe. It is absorbed through the intestines with iron. The body loses about 4 mg of manganese every day. This lost amount must be taken with food. Manganese absorption increases in iron deficiency. Bivalent manganese mixed with blood converts into trivalent manganese and transferred by being bound to beta-1-globulin. Transferrin has also been reported to carry manganese (7). Weight loss, nausea, vomiting, skin irritation, slowing of hair growth and hair greying have been observed in people who applied diet without manganese for experimental purposes. Manganese is also required for the normal development of the fetus in the mother's womb and for hyaline cartilage and nerve tissue to function normally. It has also been reported to be important for amino acid and carbohydrate metabolism (1,2).

1.15.2 Disorders Caused by Manganese Deficiency

Main symptoms of manganese deficiency have been reported as **disc and cartilage** problems, glucoses intolerance, weakening of brain functions, imbalance in middle ear, disabled births, decreased productivity, constant fatigue, memory problems, infertility, weight loss, growth retardation and developmental disorders especially in children and infants, abnormal formations in bones and cartilages, nausea, vomiting, hair greying and slowing hair growth.

Manganese poisoning does not occur by taking excess amount of manganese with food. Occasionally, it may occur in metal workers working in manganese production. Chronic manganese poisoning can often be seen in miners, foundry workers, welders, employees in chemical and pharmaceutical industry. **Parkinson's** disease and similar nervous system disorders occur when excess amount of manganese is taken in the body. Nervous system disorder caused by manganese and salts in work places are called **Manganism**.

1.15.3 Manganese-Rich Foods

Manganese is found mostly in whole grains, green leafy vegetables, walnuts, almonds, hazelnuts, peanuts and especially in tea we drink every day. It has been reported that a cup of tea has about 1 mg of manganese (4, 18).

1.15.4 Reference Body Analyses

The amounts of manganese wanted healthy adults have as follows: 0.4-11 ng/mL in blood analysis, 7.7-12.1 ng/mL for serum-plasma (1).

1.15.5 Studies about Manganese

British physician Barlow et al. found that some schizophrenic patients have very low amount of manganese and high amounts of iron and lead in their hair analysis. They reported that they achieved good results by applying manganese chloride treatment to these patients.

1.16 Lithium (Li)

1.16.1 Importance of Lithium

Lithium has been used in the treatment of various diseases since 19th century. It is used firstly in the treatment of **gout** since lithium urate's easier solubility than sodium and potassium urate, then with the aim of replacing sodium in less saline diets, and later in the treatment of manic depressive patients as psychoactive drug. However, since lithium leads to poisoning, patients treated with this treatment should periodically measure lithium levels.

Although the effect of lithium is not exactly known, it is thought that it takes its effect by partially replacing the other positive ions such as Na^+, K^+ ions. By replacing the ions of Na^+ and K^+ in biological events, lithium ion acts as Na^+ ion out of the cell and K^+ ion inside of the cell in the human body. In cell transport systems, it enters and exits the cell by replacing carrier proteins or other ions. Thus, it is believed that it has effects on hormone activity by changing the structure of the proteins which forms the biological macromolecules in the cell, transmittance of cell membrane and hormonal enzymes by changing the cellular pH, ionic strength and osmolarity. In humans, it has an inhibitive role of especially enzyme activities. It is also effective on carbohydrate metabolism (19).

1.16.2 Toxic Effect of Lithium

Excessive amount of lithium prevents ion transfer from cell membrane, as well as disturbing the fluid balance. Its major symptoms include nausea, vomiting, shivering, thirst, excessive urination, swelling thyroid

gland, numbness, confusion,maladaptation and coma in severe cases. Patients using lithium should be under physician control.

1.16.3 Studies about Lithium

Lithium is found as free without binding to protein in blood, and commonly inside and outside of the cell in the body. The blood level of lithium has been calculated to be 0.2 mEq / L.

Lithium salts have found wide use in medicine in recent years. It has been understood that lithium has an inhibitory effect on the adenyl cyclase enzyme, which is stimulated by many hormones. This feature is often used in treatments.

The effects on glucose tolerance in humans have been examined by various researchers and conflicting results have been obtained. In another study, it has been found that in humans, the effect of lithium on insulin secretion is variable, and that this variability is related to Ca ion concentration, the effect of lithium on glucose utilization is also dependent on Ca ion concentration (19).

1.17 Cobalt (Co)

An adult human body contains 201.1 mg of cobalt (1). %43 of this is in muscles, %13 is in bones and the rest is in the other tissues. %4 of vitamin B12 is cobalt. Cobalt has been reported to be effective in the use of iron, metabolism of sulfuric amino acids, synthesis of thyroid hormone and hypertension. Cobalt deficiency is not seen when people take sufficient amount of vitamin B12. In 1966 in Canada, Belgium and the United States, cardiac insufficiency was detected in many beer drinkers, and it was understood that this disease originated from cobalt that added in (2, 4, 7).

1.18 Boron (B)

In addition to being used for different purposes in hundreds of industries, boron is also an important mineral in terms of health. The amount of boron that should be taken daily in adults is 13 mg. It contributes to the protection of teeth and bone health by helping to protect and effectively use of Vitamin D in the body with calcium, magnesium and phosphorus minerals. It improves brain functions. It supports the functioning of estrogen hormone and reduces bone loss. Another feature of the boron isbeing a natural antibiotic. Boron is also used for medical treatment.

In particular, it is used in the treatment of bone loss, migraine, nerve diseases, malaise and cancer (20).

Failure to take the boron in sufficient quantity will result in deficiency of vitamin D, resulting in bone loss and thinning, and easier fracture of the bones. In addition, lackof concentration and memory weakness can be seen. Taking high doses may cause toxic effects.

Boron is found abundantly in almonds, hazelnuts, apples, grapes, strawberries, dates, peaches, plums, parsley, garlic, broccoli and tomatoes (20)

1.19 Nickel (Ni)

In limited studies, it has been suggested that nickel from daily nutrients should be less than 150 mcg. The human body has different amounts of nickel in the lung, liver, kidney, and gut tissues. Nickel is included in DNA and RNA. As age progresses, the amount of nickel in the lung increases. Reference quantities should be in the range of 1-28 mcg / L in healthy adult human blood, 48-106 mcg / L in erythrocytes, 0.6-7.5 mcg / L in serum or plasma, 0.1-10 mcg / L in urine (1). Nickel has the effect of lowering the blood sugar of insulin in some animals. In humans, it has a function in the healing process against the blood pressure-raising effect of adrenaline.

1.20 Flour (F)

It is a very important element for dental and bone health. It prevents tooth decay, bone loss and fracture. Children require 1-2 mg flour daily and for adults it is 2-3 mg flour.

Fluor deficiency causes the teeth to weaken and causes bone loss. Fluor deficiency should definitely be avoided especially in infants and children in the age of development.

Fluor Excess and Flora Losses: It causes yellowing of teeth and destruction of tooth enamel.

The major nutrients containing flour are saltwater fish, especially salmon and tea. Since there are only a limited number of foods containing flour in the body, giving importance to foods containing flour and brewing tea with flour water is the most effective method for deficiency of flour.

2. HARMFUL HEAVY METALS FOR BODY

2.1 Mercury (Hg)

2.1.1 General Information about Mercury

Mercury compounds are used in industry in manufacturing of paint, explosives, electronic devices, accumulators, amalgam dental filling, and thermometers and so on. It is a metal that is present in various compounds in water and air, the soil in the environment and has harmful effects when taken in the body. It is in liquid form at room temperature. The boiling point is 357°C. When the weather is hot, some of the mercury will evaporate. The amount of mercury in the atmosphere should be below 0.01 mcg / m^3. In large metropolitan cities, the amount of mercury in the air varies between 1-14 mcg / m^3. In the vicinity of the chlorine-alkali factories, at most 100 mcg / m^3 in atmospheric and 20 mcg / m^3 in mercury mining industries have been measured. In acute poisonings caused by respiration in factories working on mercury, the concentration of lethal mercury in the air is 10 ppm. The lethal dose of mercury compounds is 1 gram. Mercury in the form of dust or gas passing through the atmosphere can be removed by respiration (21). In addition, mercury in the atmosphere returns to the earth with precipitation and is mixed with the soil and water. It has been reported that the amount of mercury emitted to the earth by precipitation is about thirty thousand tons. The amount of mercury in clean water is less than 0.1 mcg / L.

Different amounts of mercury can be found in foods. For foods other than fish, the amount of mercury is less than 0.05 mg / kg if there is no contamination. Mercury has been detected in fish that live in clean water less than 0.2 mg / kg, and in mercury-contaminated water, up to 20 mg / kg. It is hazardous that the maximum amount of mercury in continuous breathing air is **0.05 mg / m^3, 0.005 mg / L** in drinking water and **0.05 mg / kg** in foods. If pure mercury is taken into the body by mouth or by inhalation, it is quickly thrown away (22).

In contrast to lead and cadmium, mercury does not stay in the body for long. There are three groups of mercury as metal, inorganic mercury compounds and alkyl mercury compounds known as methyl or ethyl. The toxicity ratings of these compounds are different. Although it is a weak possibility that metallic mercury is absorbed from the digestive tract and mixed with the blood, it can easily accumulate in the

lungs through respiration. By being absorbed low in inorganic mercury compounds and ethyl-methyl compounds moderately it can get into the blood. Metallic mercury, which can get into the blood, accumulates in the brain and kidneys and affects the nervous system. Inorganic mercury compounds accumulate in the kidneys and cause kidney disorders. Alkyl compounds such as ethyl-methyl affect the nervous system. Oral ethyl-methyl mercury compounds are the most toxic. It is very dangerous for a person weighing 0.4 mcg / kg day or 70 kg to take an alkyl mercury compound of 30 mcg or more. If there is 20-40 percent of methyl or ethyl mercury in the daily diet, it can lead to continuous destruction of the brain. There is mercury in the amalgam fillings (silver fill) used by the dentists. It affects the brain and memory when it is mixed with blood (6).

As in the case of arsenic and antimony poisonings, they are combined with sulfhydryl groups in the cells to make the enzyme systems of the body inoperable. Mercurial compounds are also used in the disinfection of cereal seeds. Instead of planting these seeds in the soil, making bread was resulted in the death of hundreds of people in Iraq alone. The use of these seeds as animal feeds has also caused problems with various animals and people consuming them. The result of making bread from such medicinal wheat was in Pakistan in 1961, in Iraq in 1960 and 1965, and in Guatemala in 1965 (6).

FAO / WHO reported the maximum amount of mercury that could be taken from food to 1-1.2 mg / man / month. In some countries, literature values were found to be 0.2-0.3 and the average value for adult-child was 0.2 mg / man / month.

2.1.2 Studies on Mercury

Between 1953 and 1960, fishermen families living in Minamata Bay in Japan suffered from **Minamata** nervous disorder, which is known as the region. This disease was caused by the evacuation of a waste from a petrochemical factory that operates acetaldehyde into the bay. This factory used mercury oxide as a catalyst and discharged Methyl-Hg wastes into the bay. Mercury methyl is most prevalent in pregnant women and children with mental deficiency were born. Researches on fish caught in the bay revealed that it contained mercury up to 100 mcg / kg. The mercury that comes from fish plays an important role on human health. Mercury-contaminated water is often encountered in people with cognitive disturbances such as fatigue, headache, memory

problems, and impaired concentration. More than 3,000 people have been affected from this disease (6).

Living organisms in areas where a paper mill in Sweden and an operating that produces chlorine and sodium hydroxide electrolytically from sodium chloride in Canada they have dumped their wastes have found high amounts of mercury. Mercury is also used as a dental filling amalgamation. In a study conducted in the United States, it has been mentioned that mercurial tooth fillings may harm white blood cells in the immune system. Salty foods and bacteria in the mouth can make toxic effect by turning the mercury in the mouth into methly mercury. Some people who have mercury amalgam fillings in their mouths have been found to have had skin eruption.

In the south of France, the pollution of the seas increased the cases of poisoning and in hair analyzes of the fishermen there have been high concentrations of mercury.

As a result of analyzes of some foods and their contaminants in terms of study of heavy metal pollution in the Marmara region where the industry is intensive in our country and the results of investigating its sizes reached have resulted in the rate of mercury being 0-0.005 ppm in regional potable water, 0.005-0.1 ppm in fruit juices, 0.03-0.088 ppm in surface and coastal waters, 0-0.62 ppm in seafood, and 0-0.20 ppm in some animal products and organs (22).

2.2 Lead (Pb)

2.2.1 General Information on Lead

With the development of technology, pollution of the environment and poisonous lead wastes that lead to this pollution have also increased considerably. The amount of lead measured in cities is higher than in rural areas. Lead compounds are used in the production of various parts, in various alloys, solders, cables, paints, petrol and decorative glaze because of the production of accumulators in the industry, the melting point is very low (327 ° C) and it is very easy to shape (23).

2.2.2 Main Lead Sources in our Environment

These are exhaust gases, burning of coal, lead smelting furnaces, dust and dirt, drinking water and lead piping, leaded household goods, lead paints, batteries, electronic dumps, glazed paste, solder, leaded cartridges, cigarettes, beer etc.

Significant quantities of lead, air, water take into soil from these sources. The most important source of spreading of lead in the environment is the exhaust gas waste. Tetraethyl and tetra methyl as alkali lead compounds have been added to gas for about 50 years to prevent collision in the engines. Only in 1973, the amount of lead that is included into the gas all over the world is 380 thousand tons. In some European countries the amount of lead added to gasoline is reported as 0.40 grams per liter (in the USA this amount is 0.13 g / L). During combustion of the fuel by transforming into lead compounds such as the tetra ethyl, lead chlorite, lead oxide is thrown out in the form of lead exhaust gases.

Approximately half of the lead released from the exhaust gases was found to droop by spreading over a 3-meter area on the side of the road. The amount of lead in plants located on the road sides, where the traffic is heavy, increases up to 100 mg / kg. In industrial areas, lead is released into the environment as waste. In studies conducted, 157 ppm was measured at a distance of 1.2 km from the factory, 47 ppm at a distance of 2 km, and 22 ppm at a distance of 3 km from the smelting factory in the plant cover. In lungs of cows grazing in this area were found to have 6-18 ppm of lead up to 3 km in distance, and 6 - 25 ppm in distance of 3 to 6 km.

While the lead concentration in the air of large cities is between 2-10 mcg / m^3, in rural areas this amount is less than 0.2 mcg / m^3. It is important that the breathing air should be extremely clean for a healthy life, as an adult man is estimated to breathe about 20 m^3 per day, or about 7300 m^3 per year.

Other lead contamination ways may include the use of leaded faucets and pipes in drinking water, soldered tins and canned boxes, glazed or dyed plates for decorative purposes, pots such as cups, lead arsenic spraying agents used in fruits and vegetables etc.

Generally drinking water contains less than 0.05 mg /L lead. However, in some cities where lead water pipes are still used, the lead in drinking water can reach up to 2 mg / L. This situation is extremely harmful to human health. For this reason, the use of leaded pipes for drinking water and especially the examination of materials in old buildings is necessary. Lead should be less than **0.01 mg / L** in drinking water.

The glaze is prepared with a mixture of lead compounds and other inorganic metal oxides. The various home furnishings produced are ornamented with such glaze and dyes as decorative with different colors in order to make the product more attractive. The painted

surfaces prepared with these compounds should be controlled for health of the consumer. For example, in Chinese porcelain, 100 g of lead was detected as a result of a contact of decorative glazed paint with high acidity food material. In a 1.5 liter Spanish drinking glass, 2.16 grams of lead was dissolved. Another cause of lead pollution in our country is that the nutrients are packed with old newspapers and book pages. The lead in well-untapped canned food boxes may also interfere with foodstuffs.

Lead is passed the human body through the respiration, digestion and skin. The most dangerous of these is the respiratory passage of the body. Lead through respiratory is mixed from the lungs and about 80% is bound to phosphate in erythrocytes and some of them to plasma proteins. Lead enters into organism accumulates in various organs and tissues like liver, spleen, bone marrow, kidneys. The uncontrolled lead molecules then accumulate in the bone tissue as lead phosphate compounds, depending on the calcium.

Lead taken by digestion turns into chloride and goes to liver by mixing with blood. Most of it is thrown away with bile and stool. In humans who directly contact petrol and other lead compounds, the lead can mix with blood. Lead is an element that can stay in the body for a very long time. Its biological half-life is 2 years.

The allowable daily lead intake for humans is **5** mcg / day with respiration and **30** mcg / day via the digestive passage (24). Critical cells for lead are erythrocytes in bone marrow. It does not cause intoxication in a short time, but when it is accumulated in a certain amount, it destroys blood and blood-forming centers. The deterioration of more than 1000 in 1 million erythrocytes in blood is a sign of lead poisoning. In recent years it has been understood that lead binds to human erythrocyte proteins, especially hemoglobin. The lead has a tendency to accumulate more in the bones. In many studies it has been mentioned that in adult humans, 95% of the lead entering the body has accumulated in the bones over time. Some of the lead in other organs and tissues are excreted, while others pass into bone tissues over time. The lead is largely removed from the body by the kidney and through the digestive system, sweat, hair and nails respectively. The amount of lead taken from the oral route is less than 100 mcg in America and less than 30 mcg in Europe. This rate is found at 70 mcg / day in our country. 35 mcg / dl of lead taken daily from the body is excreted in the urine. In our country, lead poisoning is the first among occupational diseases and, if these conditions continue, over time it will be the greatest social risk (21,25).

As a result of the studies, it has been reported that the accumulation of lead in the body leads to hyperactivity, learning and behavior disorders in children and to lead poisoning in women during pregnancy and lactation periods. Lead also damages the immune system and significantly reduces the resistance to infections (23).

2.2.3 Symptoms of Intoxication

The first signs of lead poisoning are nausea, vomiting, and metallic taste in the mouth, dark-colored **Burton lines** on tongue, heart disorders, nervous system disorder and coma. In chronic poisoning can also be caused by a variety of disorders such as dark lines in the gums, anemia, gastrointestinal disorders in the mouth as metallic taste, nervous system disorders and muscle insufficiency, hypertension and heart disorders, anemia and erythrocytes deformities, renal insufficiency, gout.

The most common digestive system symptoms are abdominal pain, metallic taste, nausea, loss of appetite, constipation, yellow-brown **Burton line** in the gums, and lead colic mixed with acute abdomen.

In the nervous system: Brain edema and motor paralysis, right hand radial nerve paralysis, damage to the hemopoietic system. It has a negative effect on kidney and iron in blood.

2.2.4 Studies on Lead

Surveys show that lead accumulates in bone tissue, kidney, spleen and blood most and small amount in muscle.

Lead analyses made at first 5 cm depth on the ground near Ankara-Etimesgut highway showed that the lead content varied from 98 to 124 mcg / g at 2 m distance and from 12.7 to 50.4 mcg / g at 500 m land. The amount of lead was found more on the roadsides where the city traffic was dense (23).

Studies on the effect of lead on children have shown that the lead concentration in children aged 4-13 years is about 10-13 mcg / 100ml in Ireland, 18.6% of 6100 children in America is above 39 mcg / 100ml and 3.1% of them are 59 mcg / 100ml. In another study conducted also in children in a hospital in America it was showed that the lead

concentration had an adverse effect between 0-21 mcg / 100ml, the lead effect increased between 21-60 mcg / 100ml, and the lead poisoning case was above 60 mcg / 100ml.

The reason why the deaths from cardiovascular diseases in the UK are mostly from specific region is due to fact that the tap water in this area is very high in lead and very low in calcium and magnesium.

In the studies conducted in the Marmara region where the industry is intense in our country: the amount of lead was found between 0.12-1.36 ppm in Sea of Marmara and Gemlik bay, and the amount of lead determined in seafood was found between 0.20-1.96 ppm (23).

The Canadian food and drug agency has stated that the amount of lead that can be found in fish as human food should not exceed 2 ppm.

In London, high concentrations of lead, such as 85 mg / kg in the dusts around the roads in rural areas and 1000 mg / kg in the city streets, were determined.

2.2.5 Protection from Lead

- The use of unleaded gas should be widespread and exhaust gas inspections should be conducted at frequent intervals.
- Calcium, vitamin C, zinc, iron, magnesium, vitamin D, chromium, vitamin E and selenium, protein-rich nutrition should be applied to adults and children living on the street and it should be avoided from the main roads as far as possible.
- It should be ensured that vegetable and fruit gardens are at a distance from the highways.
- Meat and milk of animals such as cows, sheep, lambs and chickens crop on the roadside and in the vicinity of a factory should be controlled and necessary precautions should be taken.
- Schools, children's gardens, parks, and hospitals should be built in clean areas away from heavy city traffic and industrial areas.
- Pregnant mothers should stay away from heavy traffic areas and industrial areas.
- The lead ratio in the blood of people who may be exposed to lead such as workers in lead-related professions, workers at fuel stations, auto drivers, traffic policemen should be checked

- Residences in cities should be away from heavy traffic and highways.
- It should be avoided from smoking and public places with smoking.
- The sides of the street should be planted and obscured.
- Leaded taps and lead pipes should not be used.
- We should stay away from superstitious beliefs such as pouring lead and drinking from melted leaded water in our country.
- Canned foods and similar type of foods in brazed tin cans should not be taken. Tinned vessels containing lead, ceramic cups glazed with lead paint, plates and so on should not be used. It is best to use plain, unpainted plates, vessels and cups.

2.3 Cadmium (Cd)

2.3.1 General Information about Cadmium

Cadmium is used in metal plating industry against corrosion and decorative purposes, with zinc in galvanized coating, solder in production of Ni-Cd accumulator and batteries, nuclear material in semiconductor and photocell production, dental amalgam, in production of photographic materials, automobile tires, plastics paint and glaze, in some insecticides. In such industrial areas, it is released as cadmium gas or solid waste to the environment. It is also found in coal and petroleum gas, in cigarette smoke, and in some fertilizers. The galvanized coating has approximately 0.02% cadmium. The melting point of cadmium is 321 ° C and the zinc is 420 ° C. Galvanized steel plates, zinc plates used in valleys, especially when compared to acidic rain water, zinc and cadmium will dissolve and mix with water. Therefore, some dissolved zinc and cadmium may be present in a galvanized water reservoir. There are averages of 0.1 mg / kg of cadmium in earth crust and 0.53 mg / kg cadmium in soil. More than 3 mg / kg of cadmium in the soil leads to toxic effects. Especially in the last 20-30 years, it has been reported that the content of Cd in the earth's soil is increasing. The most important cause of this increase in cadmium content is shown as an increase in phosphorus fertilizer, cigarette, industrial solid waste and sludge (26).

Cadmium has been reported to have an average of 30 mg in the bodies of industrialized societies, especially due to the environmental increase of cadmium. While this amount is up to 50-60 mg in people living in some parts of Japan, it is lower than 10 mg in non-industrial African people.

Cadmium can be taken through the digestive, respiratory and skin tract to the body. When taken orally, about 10% of is absorbed in the digestive tract. The rest is thrown away with urine and stool. When it is inhaled, more than half it passes through the lungs and from there it is transferred to the blood and spreads to the whole body. The most important cadmium source in a breathing air under normal conditions is cigarette smoke. In large cities and industrial areas, gases present in atmospheric emissions from combustion of coal and petroleum products, wastes containing cadmium in metal and coating industry, gases and metal vapors are highly influential on human and environmental health.

The maximum cadmium concentration in the inhaled air is limited to **0.1 mg / m^3**. The most characteristic symptom in chronic poisoning is **Fankoni syndrome** (21,24). It was estimated that the the cadmium amount of a cigarette was between 16-25 mcg according to the type of tobacco. According to this, the amount of cadmium in the blood of cigarette smokers is 2-3 times higher than the non-smokers. Other people in the community are at risk as much as they drink because they will breathe the same air in a coffee house, in a conference room, or in a smoking room. It is therefore important for cigarette smokers to measure the cadmium content of their bodies every 1 or 2 years for their health. Another source is the vessels in our kitchens. As ceramic, glass cups and vessels etc. are adorned with cadmium paint and glaze decoratively it will gradually dissolve in acidic media and may enter the body orally. In 1976, the World Health Organization limited the amount of cadmium that could enter the body to 0.5 mg / week for an adult human. In today's productions, the lip-contact in the drinking vessels is limited to leaving a mouth sliver of at least 2 cm and a maximum cadmium content of 0.2 mg per part. It is important for the health not to make decorative dyes inside the plates.

WHO / FAO (World Health Organization / Food and Agriculture Organization) reported the maximum amount of cadmium available for consumption as 1.6-2.0 mg / man / month. The literature values obtained in the studies conducted in some countries were found to be between 0.2-0.3, the mean value was 0.2-2.0 in adults and 0.04-0.61 mg / man / month in infants.

3-8% of cadmium taken to the body, shows accumulation, especially in the liver, lungs and kidneys. This amount is about 50% of the total amount of cadmium in the body (26).

2.3.2 Symptoms of Intoxication

The first symptom of cadmium poisoning is on the blood pressure. It has been determined that those who die from high blood pressure have excessive amounts of cadmium in their kidneys and in very small amounts of zinc. By entering the body, cadmium, which mix the blood, destroys the enzyme system that is controlled by the zinc by taking the place of the zinc, especially the enzyme system that controls the blood pressure. Cadmium, which is much more toxic than lead, causes diseases such as severe liver and kidney diseases, arteriosclerosis, anemia, cancer and development disorder in children.

2.3.3 Nutrition type of people exposed to cadmium poisoning

If excess cadmium is detected in hair or blood analysis, the patient must be removed from the source of cadmium source and be away from such environments. Afterwards, C vitamins which are protective iron and zinc, rich in nutrients are applied. Abundant amounts of fiber foods, fruits and vegetables should be taken. As vitamin C and iron levels are very low in cigarette smokers, cadmium levels are very high and quitting smoking is very important in terms of their health.

2.3.4 Studies on Cadmium

About 200 Japanese have been poisoned from a disease called **itai-itai** in Japan from 1940 to 1945. It was observed that a mine in Toyama, Japan, poured zinc, cadmium and lead-containing wastes into the Jintu River in the surrounding area, and the farmers watered rice fields with this water. It has been reported that the amount of cadmium in the cultivated rice is very high and that excessive cadmium causes poisoning in the villagers with bone-joint and kidney disorders. Along with poisoning, lung and prostate cancer cases are also mentioned. Further precautions have been taken to prevent further cases (21,27).

In a study made in Canada, it was reported that by making analysis of 14 elements in the hair unsuccessful children in the apprenticeship could be identified.

In unsuccessful children, the amount of cadmium and manganese is very high, while that of lithium and chromium is very low. By following a proper diet, children have improved over time.

In our country, the cadmium rates determined in seafood consumed as food in the Marmara region ranged between 0.1-1.61 ppm and in Izmit bay where the industrial pollution was intense, cadmium was found to be 0.001 ppm (22).

Cadmium analyses made at first 5 cm depth on the ground near Ankara-Etimesgut highway showed that the cadmium content varied from 2.1-3.7 mcg/g at 2 m distance and from 0.8-2.4 mcg/g at 500 m land.

In a cigarette, cadmium is estimated to be 16-25 mcg according to the type of tobacco. According to this, the amount of cadmium in cigarette smokers, in their blood, is 2-3 times higher than the non-smokers.

2.4 Aluminum (Al)

2.4.1 General Information about Aluminum

With the development of technology in the twentieth century, aluminum production has increased rapidly and today aluminum has been used for a variety of purposes in our kitchens, household goods, industrial equipment, packaging industry, cleaning materials, deodorants, coloring various foodstuffs, and as additives. The melting point of aluminum is low (660 ° C) and shaping is very easy. As previously vessels, pots, cups made from copper caused poisoning, Aluminum, steel and glass cups, takes its place.

The aluminum enters body easily with cups, some foods such as cakes, biscuits, medicines and additives. As Aluminum is a good conductor and odorless metal plate production has increased. Until recently, it was assumed that aluminum was not reactive and would not cause food poisoning. Because aluminum immediately combines with oxygen in the air, bringing the alumina oxide layer to the field and this oxide layer protects the material against corrosion. But experiences have shown that in some cases alum can be dissolved with nutrients. Therefore, aluminum is dissolved with strong acids and strong bases, if necessary. Acids and bases degrade the surface oxide layer, causing the aluminum in the bottom layer to dissolve. For this reason, all kinds of acidic fruit juices may cause interference. Fruit juices in aluminum-coated cardboards can dissolve some of the metal.

Soda is a strong base. For this reason, household goods made of aluminum should not be washed with cleaners containing soda and soda. Aluminum may be mixed into the body through certain plants such as sodium aluminophosphate-containing foods, food additives, and some plants such as tea that contain and store aluminum from the ground. Another aluminum source is water and aluminum sulphate reaction to clean the water. Aluminum sulphate and lime are precipitated as aluminum hydroxide and cleaned from water. However, the concentration of dissolved aluminum in the water also increases. Aluminum is also taken into the body as a medicine used in stomach and other disorders. However, under normal circumstances, the body keeps itself in equilibrium, and a large part of the aluminum is taken out. Therefore, 75-95% of 4-7 mg of aluminum entering the body every day is thrown out. If the mechanism of absorbing nutrients is bad, the body is diseased, or the amount of aluminium entering the body is too high, the rate of mixing with the blood may increase. Part of the aluminum is excreted through the urine and the other part mix with the blood and spreads to the whole body.

Aluminum is most abundant in the bones and lungs in the tissues. Aluminum spreads throughout the body taking the iron in the transferrin protein having the iron complexes. Transferrin collects 80% of dissolved aluminum in blood plasma. This prevents aluminum migrating to the bone marrow, causes anemia and bone diseases. Aluminum with all these qualities, mostly affects kidney patients and old people. Over the past years it has become clear that aluminum causes problems such as anemia, bone disease and dementia in kidney patients and old people.

Kidney patients on dialysis cannot throw away accumulated excessive phosphate from the kidneys. Therefore, the level of phosphates in the blood increases and accumulations of calcium phosphate occur. This cumulation bring pain to the arteries and joints. The patient is given aluminum hydroxide to prevent excessive phosphatization. These patients are dialyzed with very high concentrations of aluminum-containing water and take high-dose aluminum hydroxide medications to prevent excess phosphate. Aluminum hydroxide removes phosphate from the digestive tract by absorbing and then is expelled. Excessive aluminum mixed in the blood takes up the calcium that forms the core structure of the bone, causing softness in the bones and breakable bone problems (27).

A high amount of aluminum may also cause dementia during this treatment. In some studies, chronic kidney failure, artificial kidney cisterns have been reported to contain aluminum in the water and aluminum phosphate in the oral cavity cause dementia, as well as high levels of aluminum in the brains of dementia victims, suggesting that aluminum causes dementia. Aluminum cumulation in brain has proved to be caused dementia, although it is not exactly the cause of Alzheimer's disease (29).

2.4.2 Studies on Aluminum

From 1944 to 1979 gold and uranium mine workers are respired powder mixtures containing 85% aluminum oxide and 15% aluminum to prevent silicosis-induced lung disease by researchers in Canada and in psychological tests it is determined that their brain skills were reduced.

In the second half of 2010, in the town of Ajka which 160 km is south from the capital Budapest of Hungary, as a result of the accident happened Ajkai aluminum refinery, the largest industrial unit of the region, about one million tons of red mud containing dangerous heavy metals has spread over a 40 km2 area by the collapse of the piles of gigantic ponds where wastes were collected and deactivated. Spreaded red mud has caused a serious environmental disaster at the same time as the loss of many lives and property.

In Guam, 10% of the native Guamania and 15% of the locals of the Mariana Islands were found to have brain disorders. It was stated in the survey that this was caused by high amount of aluminum in the drinking water and in nutrients (30).

The most critical ingredient for human life is phosphate esters. In studies it is also reported that by connecting Aluminum adenosine triphosphate (ATP) it destroys the energy storage system of body, and it is binded the inositol phosphatase responsible for calcium transport. Scientists have observed that silicic acid and phosphates of aluminum are binded to the pH of the solution as a result of the study. Accordingly, Al in the blood plasma with pH 7.4 will combine with silicic acid and in a slightly acidic medium with a pH value of 6.6, Al will combine with the phosphate groups. Thus, dissolved aluminosilicates, which are not excreted by the kidney, react with phosphate esters in the cell and destroy the cellular metabolism (31).

It has been reported that inhalation of aluminum vapors and dusts in the mines and factories that operate bauxite or high doses of oral ingestion causes prostration, respiratory disorders, and fibrosis of the lungs by inhalation of aluminum salts.

2.4.3 Protection from the Effects of Aluminum

The most basic precautions to protect out health are that not to cook vegetables and fruits in aluminium pots and kitchen utensils and also not to keep acidic foods which are very often used in turkish cuisine such as fruit juices, vinegar, tomato paste, lemon, pickle, canned food, etc. within these kitchen utensils for a long period. Glass containers or Pyrex can be used instead.

Aluminum can be found in some additives, baking soda, some medicines, agglomeration inhibitor, emulsifiers, fermenters, stabilizers, thickeners, food dyes, food packing materials. It should be taken care when buying these items (6).

2.5 Arsenic (As)

2.5.1 General Information About Arsenic

Arsenic can be found in gas or solid waste materials in some chemical and metal industries. It is mainly used to prevent harmful insects as copper arsenic acetate and copper arsenide in grapery and fruit growing. Because it is poisonous substance, it is used in the construction of many poisonous plants. Arsenic poisoning presents itself in the lung, nervous system, and in the brain. It is estimated that 20-120 mcg arsenic is taken with food per person per day. Fish and seafood have slightly more arsenic than other foods.

It has been reported that arsenic concentrations is between 2 and 23 mcg / L in erythrocytes, 3 mcg / L in plasma or serum, 1.7-15.4 mcg / L in urine and between 5 and 50 mcg / L of healthy adults (1).

In Marmara Region which is an important and heavy industrial are in our country,it has been reported that Arsenic content in sea water was found as 2.0-19.2 ppm, 0.08-7.4 ppm in fruit juices, 0.2-14.4 ppm in fish and lice, 0-0.1 ppm in cattle liver and kidneys consumed as food, 0.2-0.8 ppm in milk. (22).

Schroeder and Balassa estimate that the average intake of arsenic in humans in the USA is 0.4-1.0 mg / day. They also found that the arsenic was 2.7-8.9 ppm in seafood. These amounts are above acceptable limits for human health. According to today's regulations, the amount of arsenic allowed in nutrients is 1 ppm in the United Kingdom and 2.6 ppm in the U.S. (24).

2.5.2 Symptoms of Intoxication

Arsenic is a poison that affects the nervous system. It also effects on veins, causing circulatory disorders, liver, heart, kidney, gastrointestinal and skin diseases (skin cancer, etc.). All arsenic derivatives effect on cell proteins in the body and disrupt metabolism. It reveals itself as extreme gastrointestinal disorders, nausea, throwing up, cirrhosis, edema in eyelid and face, corneal disorder, nail drop, skin breakdown as discoloring, headache, dizziness, memory and consciousness disorders, depression, asthenia, difficulty in digestion, and pain in the joints (32).

2.6 Antimony (Sb)

2.6.1 General Information About Antimony

Antimony, alloyed metals such as lead, tin, etc. in the industry are used in areas as for battery, match, varnish, ceramic, textile, tain . The use of antimony-containing materials such as solder, tin or enamel in canned food containers and some food containers can cause food contamination. Antimony is one of the elements that cause air pollution, especially in industrial cities (21).

2.6.2 Occupational Diseases and Symptoms of Intoxication

Antimony reacts with acids, such as arsenic and cause appearance of Stibin (antimony hydride SbH3) gas as toxic compound. It causes nausea, vomiting, headache, asthenia, jaundice, etc. even with the short respiration. People who are constantly in these environments are more affected. The effect of SbH3 gas on the skin is more than arsenic. The toxic effect of this gas is similar to the effect of hydrogen arsenide and leads to diseases such as digestive disorders, respiratory tract disorders, rapid breakdown of blood erythrocytes, and myocardial anomalies. Inhalation of antimony compounds in the form of dust or vapor can cause lung problems, respiratory insufficiency and heart problems. The Occupational Health and Safety Agency (OSHA) limits the maximum amount of antimony per day that can be found in the working environment as 0.5 mg / m^3 (24,33).

2.7 Beryllium (Be)

Beryllium was first investigated on the deaths of workers working in the production of fluorescent lamps and was observed to cause lung diseases in workers. **Berylliosis** or **Beryllium** disorder is a lung disease that usually occurs as a result of exposure to high levels of beryllium compounds. This disease usually occurs with the rate of beryllium exceeding 100 mg / m3at as a result of an accident. Researchers tested beryllium-containing phosphorus material on animals and found that it caused bone cancer in animals. As it is known, the **phosphatase** enzyme in the body assists in the cumulation of calcium phosphate material which hardens the bone, and magnesium is very important for the phosphatase enzyme. Beryllium does not cause cancer in humans, but it damages the lungs. For this reason, beryllium is no longer used in the manufacture of fluorescent lamps. A very small amount of beryllium prevents working of enzyme phosphatase. By entering the enzyme Beryllium takes up the magnesium and releases magnesium, making the enzyme noneffective. As is known, this enzyme is necessary for calcium phosphate material which hardens the bone (20,21).

2.8 Tellurium (Te)

Telluride, which is a bright silvery-white color and easily breakable, is a very soft element and enters the group of nonmetals and metalloids although it shows metallic features. During the processing of lead, copper, bismuth, precious metals and nickel ores, tellurium is gained from sulfuric acid plants as byproduct. The main source is copper anode mud. Tellurium is usually found in silver, copper and sometimes gold intermetallic compounds [Ag2Te, Cu2Te and (Ag, Au) Te2] in anode mud an average of 0.5-10% and is separated from these anode mud together with selenium. Elemental tellurium is less toxic than selenium, but organic compounds and reactive tellurides (telluride) can be harmful for health. Hydrogen telluride (H2Te) and tellurium hexafluoride (TeF6) are very toxicological and colorless gases.

2.9 How to Minimize the Impact of Toxic Metals

- The minimum values notified by health institutions should not be exceeded.
- By making controls of the flammable gases and waste material in the factories it is necessary to filter out harmful substances and not release into the environment.
- It is important for people working in the industry to take necessary preventive measures in terms of health and work safety.
- Exposure to these metals at home and at work should be avoided. Especially the cigarette smoke, exhaust gas and improper cups for cooking food should be avoided.
- Foods that are sold in the open and unspecified are not to be taken, and fruits and vegetables must be cleaned thoroughly.
- Abundant fiber foods, high nutritional value vegetables and fruits should be eaten.
- Forestry areas should be visited to have clean air by getting out from industrial areas and large traffic-intensive cities.

2.10 Industrial Disasters in the World and the Region with Dirtiest Environment

West Virginia, USA : In the Hawks Nest Tunnel Facility, which lived between 1927 and 1932, 476 workers, lost their lives because of silicosis.

Seveso, Italy: On July 10, 1976, 100,000 animals were destroyed and 193 people living in the environment were also infected due to dioxins released by a company in Seveso, **Italy** to atmosphere. This disaster has caused the formation of the Seveso Directives by the European Community and the implementation of stringent industrial regulations.

Bhopal, India: Bhopal Disaster, one of the biggest industrial facilities in the history, which erupted on December 3, 1984, is derived from gas escaping from a large chemical factory. 40 tones of toxic methyl isocyanate released in the atmosphere resulted in more than 10 thousand cancer, growth retardation, injured birth and more than 100,000 poisoning cases in the area. After this accident whose environmental impact was just as scary as the Chernobyl disaster, state of Bhopal was declared a natural disaster area.

Norilsk, Russia: It is the world's largest heavy metal-processing industrial city, founded in 1935 by Russia in Siberia. Because of tons of copper, lead, nickel oxide and sulfur oxide wastes per year, soil and water resources have been seriously damaged and the working life of the workers employed in the factory has been shortened by about 10 years compared to the average. 16% of child deaths in the region are caused by stillbirths, lung cancer and disorders by these wastes.

Sukinda Valley, India: Sukinda Valley in Orissa state of India has 97% of the chromite ore used in chrome plating and stainless-steel production of the country. During mining operations in the region, 2.6 million people living here have lung, asthma and stomach diseases, infertility and birth defects, due to contamination of Cr + 6 toxic wastes into drinking water, soil and air. The Blacksmith Institute declared this valley to be one of the 10 regions of the world's dirtiest surroundings.

Chernobyl, Ukraine: Due to the nuclear disaster in 1986, 4000 people, mainly from Belarus, Russia and Ukraine, were infected with thyroid cancer and 10 million people were affected by this disease. About 125 thousand people died in this disaster. It is the largest nuclear disaster after atomic bomb in Hiroshima and Nagasaki.

Fukushima, Japan: It was occurred after the 2011 Tōhoku earthquake and tsunami. The great environmental disaster was occurred with radioactive material released to atmosphere in Fukushima 1st Nuclear Power Plant. The accident is the world's second-largest nuclear accident after Chernobyl. In this accident, hundreds of thousands of people have been exposed to radioactive contamination and they were evacuated from the area.

Dzershinsk, Russia: Between 1930 and 1998, it is a region that Russia produces biological and chemical weapons. 300,000 people have been infected with cancer, lung and kidney diseases due to the wastes being left. It was chosen as the world's chemically dirtiest territory in the Guinness Book of World Records.

Agbobloshie, Ghana: In Ghana, about 215,000 tons of electrical and electronic waste are stored every year and these materials are burned to produce copper. The smoke released to the environment distributes the lead wastes to the whole region. Such activities are also carried out in the Guadalajara region of Mexico. People living around are under risk.

Citarum River, Indonesia: Due to chemical wastes such as lead, aluminum, manganese, etc., which are discharged the Citarum River in the West Jawa region of Indonesia, 500,000 people were directly affected and 5 million people were indirectly affected.

Hazaribagh, Bangladesh: Leather enterprises in this city use Cr^{+6} solution in their operations and discharge their wastes. For this reason, about 160,000 people were affected in the environment, especially in cancer.

Kabwe, Zambia: In 2006, around 300,000 people in this area suffered environmental pollution due to lead wastes contaminated with soil and water.

Kalimantan, Indonesia: 225,000 people have become ill due to mercury vapor emissions from the mercury used to extract gold from small gold operations in this area.

Matanza Riachuelo, Argentina: It has been reported that more than 20,000 people in the region are affected by the contamination of zinc, bauxite, nickel and chromium wastes into the Matanza river by the 15,000 industrial enterprises located near the capital Buenos Aires.

La Oroya, Peru: Incidences such as stillbirth, neurological disorders, poisoning and lung cancer due to lead waste and toxic gas emissions from metalworking facilities in the region were very common. Along with acid rains, 35,000 people have been affected and it has been reported that the world has the highest infant mortality cases.

Mailuu-Suu, Kyrgyzstan: It is the Asia's largest chemical waste disposal due to radioactive waste from the uranium mine.

Sumgayit, Azerbaijan: This region is where there were factories producing a large number of industrial and agrochemical chemicals and around 70-120 thousand tons of harmful mercury waste and emissions were released per year during the Soviet Union period. 275 thousand people were affected in the region and the cancer cases increased by 50%. Genetic diseases and preterm delivery have also been observed.

Tianying, China: This region is the China's largest lead production facility. 140,000 people living in the region have been reported bullet poisoning, mental retardation, low IQ, hyperactivity, learning disability, hearing and visual impairment, developmental disability, bowel, kidney and brain injuries, especially in children.

Guiyu, China: It's the China's largest electronic garbage. In this electronic garbage, the wastes are selected by separating into the pieces and baked and kept in order to convert the precious metals. It is estimated that the people living in Guiyu, the second most polluted place in the world, are under high risk.

Hayna, Dominican Republic: This is a region where battery and accumulator waste from industrialized countries are subjected to the most uncontrolled recycling. During the recycling process, releasing of the poisoned lead has been caused environmental pollution. Mental and physical developmental disorder of children living in the environment has been reported particularly.

The United Nations has yearly reported that more than 50 million electronic waste, even though it contains hazardous substances such as lead, cadmium, chromium and mercury, has been deposited to the nature and that the harmful substances that are released poison the environment by mixing with soil, air and groundwater.

More than two thousand nuclear tests have been conducted until today. These experiments have been made in the atmosphere, underground and oceans, often in regions where different local people live. Experimental zones have been abandoned in time, while non-abandoned zones are still at risk of radiation. The PPNW (Physicians for the Prevention of Nuclear War) organization struggling to prevent the International Nuclear War. The PPNW has been reported that 2.4 million people's lives are in danger due to nuclear tests done between 1945 and 1980.

As it is understood from the examples above, industrialized countries put their wastes into production by recycling them in undeveloped countries. They had made their nuclear tests in different regions in past. But, people in these regions have been still suffering from all the problems of environmental impacts.

3. METALS USED AS IMPLANT, PROSTHESIS AND FILLET

3.1 Introduction

Although biomaterials are new materials that are rapidly developing today, it is based on the first ages in terms of application. The artificial eyes, noses and teeth found in Egyptian mummies before Common Era are the best evidence to explain this. The use of gold in dentistry dates back to years of 2000. Since the 19th century, the use of intra-body implants and prosthetic materials has increased. In 1880 it was seen that dentures made of ivory and bone were placed in the body. Vitallium, the first metal prosthesis, was produced in 1938. In 1949, screw and cage implants made from **vitallium** were developed.

After the 1960s, stainless steel hip prosthesis have begun to be used as biomaterials, and with the development of technology, a great number of metals, ceramics and PE, PTFE, PU, PA have been used in the last 50 years such as metals Gold, Tantalum, Stainless steel, Titanium alloys, Cobalt, Molybdenum, Magnesium, ceramics polymers such as PE,PTFE, PU, PA, PMMA,PET,SR,PS,PLA,PGA are used to repair and replace various parts of the body. Metals are generally preferred in terms of being very strong and durable, easy-to-shape, and resistant to wear. Negative aspects include low bioavailability, corrosion, stronger structure compared to tissues, and allergic tissue reactions. Orthopedic area, metals preferred in dental implants and prosthesis, are no preferred in heart, veins and soft tissue system. But in the future, the share of metal composites appears to be even greater in these areas (34).

Vanadium steel, the first metal alloy developed to be used as a biomaterial in the human body, has been applied as a screw and plate in the treatment of broken bones. In addition, metal materials made of stainless steel, chromium, cobalt, nickel, titanium, tantalum, niobium, titanium, molybdenum and tungsten alloys have been successfully used in the body (35).

Today, half of the people over 40 years old have a variety of bone disorders, and as a treatment, prosthesis is used around the world about 500,000 hip bone joint and 400,000 patella joints per year.

In addition, injuries, disablement, fracture-dislocation cases and organ loss occur every year in traffic accidents in our country and in the world. Only 304,421 injuries have been reported in 2015 in our country alone. With addition to natural disasters, terrorist attacks, internal conflicts and occupational accidents, the use of biomaterials is predicted to increase even more and it is understood how important it is in environmental treatment practices.

Figure 7. Metal Prosthesis Materials in Bones

Temporary evaluation materials used in the body to hold two pieces of bone together until the bone heals, usually are applied to make movement smoothly when joint surfaces corroded, degenerated, calcified in the spine, arms, legs, knees and long bones as prosthetic prostheses.

Figure 8-Metal-Nonmetal prosthesis materials in joints

Due to crystal structures and very strong metallic bonds, the percentage of metals and alloys bearing superior mechanical properties in the area of biomaterial is very important. Metallic biomaterials, especially those with good corrosion and mechanical properties, help the hip and knee joints to heal and consolidate fracture areas of the spine and the external teeth by replacing the implant with prosthetic materials or by combining the fractured area with layers and screws (36).

Figure 9- Metal-Nonmetal prosthesis materials used in our body

It has emerged that biomaterials can be used to repair deformed joints and organs after metal has taken its place as a connecting material such as screws, nails, plaques. In particular, biomaterials used in the replacement of joint parts for the last 60 years serve purpose today in the field of orthopedics. Nowadays, AR-GE studies on living materials with the most suitable and compatible materials continue at a great pace. The most frequently used materials and areas of use are given in Table 13.

Figure 10. Metal prosthesis materials in hands and feet

Prosthesis and implant materials must have the following characteristics in order to be used in the human body:

1. It should be in biological harmony with human body,
2. It should be sufficiently resistant to static and dynamic loads,
3. It should carry the physical and mechanical properties of the part to be replaced,
4. It should not enter into reaction with body fluids, should not cause toxic and allergic effects on the body,
5. It should not damage normal tissue around

Live tissues can react to biomaterials in two ways. These are regional and general reactions. When an inert substance is placed in the living body, the first reaction will be regional.

After the biomaterial is placed a membrane of fibrous cartilage that separates from normal tissue covers the material. This membrane is a reaction of the body to inert substance. The inertness of the biomaterial depends on its body fluids and ion exchange rate. During metallic dissolution of pure metal implants and prostheses were observed to be covered with fibrous membranes.

Table 13. Biomaterials used in human body

FIELD OF APPLICATION	MATERIAL
SKELETAL SYSTEM	
Joints	Titanium, Ti6Al4V alloy
Broken Bone Junctions	Stainless Steel, Co-Cr alloys
Bone Backfill Material	Pol Methyl Methacrylate (PMMA)
Bone Malformation	Hydroxyapatite
Artificial Tendon and Bonds	Teflon, Polyethylene terephthalate
Dental Implants	Titanium, Alumina, Calcium Phosphate
CARDIOVASCULAR SYSTEM	
Vascular Prosthesis	Polyethylene, Teflon, Teflon, Polyurethane
Cardiac Valves	Stainless steel, Silicone, Chrome, Cobalt alloy
Catheter	Silicone rubber, Teflon Polyurethane
ORGANS	
Artificial Heart	Polyurethane
SENSE ORGANS	
Inner Ear Channel	Platinum Electrodes
Intraocular Lenses	PMMA, Silicone, Rubber, Hydrogels
Contact Lenses	Silicone-Acrylate, Hydrogels
Cornea Bandage	Collagen, Hydrogels

It has been observed that porous prosthesis with a bore diameter of 1 mm or less, allowing fluid flow through and around them, are not discrete in the tissue and adhered to the tissue by progressing the per papillary tissue through the bores. Advantages of porous metals are,

a. The bore diameters are greater than 100 microns and the presence of channels connecting these bores,
b. The inertness of the main structure of the material and its coincidence with the tissue,
c. Coating on complex surfaces,
d. Resistant to cracking when pressure is applied,
e. Making incorporation by progressing surrounding tissues into bores

Unwanted features,

a. Because of its large surface area, the possibility of corrosion during prolonged use,
b. Technical difficulties in bringing bone surfaces with metals
c. The difficulties in removing the prosthesis from the body because of incorporation when it needs to be removed again

Titanium oxide, titanium aluminate and aluminum oxide ceramics to be used in joint prosthesis have also been found to be biocompatible with corrosion-resistant metals (36).

Polyethylene is the best adjusted prosthesis material in plastic materials. The best biocompatible materials among other non-metallic prosthetic materials in polyethylenea are graphite fiber, carbon, silastic, polyethylene, polytetrafluoroethylene and polyphenylene oxide.

The general reactions that the prosthesis constitutes are through ions that released to the body fluids circulation. Irritability cases against metals can occur in the use of metal prostheses. Allergic cases with metal sensitization, especially nickel ions, are very common in patients treated with hip prostheses (37).

The most important thing to know here is that the life of all materials is limited. With the latest developments in technology, implant and prosthetic materials used in orthopedics, cardiovascular and dentistry have been used for more than 15 years.

3.2 Metallic Implants and Prosthesis Materials Used Most in Our Body

1. Stainless Steel
2. Co-Cr-Mo Alloys
3. Titanium Alloys

3.2.1 Stainless Steels

The first metallic biomaterial produced using stainless steel is 18/8 Cr-Ni stainless steel implants. It is generally preferred that the biomaterials are made from Vanadium due to their strength and high corrosion resistance. ASTM 316 stainless steel was started to be used later. With the addition of Molybdenum as an alloy element to the 18/8 CrNi stainless steel alloy, ASTM 316 L steel is obtained by increasing the corrosion resistance. Metallic biomaterials made from ASTM 316 and 316L austenitic stainless steels are quite common. In this steel, there is an additive of 0.03 Carbon, 17-19% Chromium and 12-14% Nickel and Molybdenum (36).

3.2.2 Cobalt-Chromium (Co-Cr) Alloys

There are two types of cobalt-chromium alloys used as prosthetic material. These are,

1. Co-Cr-Mo (Cobalt-Chromium-Molybdenum) alloys and
2. Co-Ni-Cr-Mo (Cobalt-Nickel-Chromium-Molybdenum) alloys.

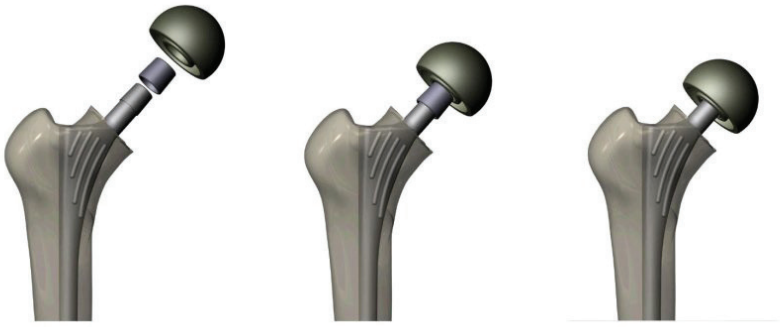


Figure 11. Metal Hip Prosthesis

Figure 12. Stainless Steel Implant Materials

Co-Cr-Mo alloys are used as root in toothless jaws and as bone implant material in newly developed artificial joints. The first Chromium-Cobalt tooth implant was introduced by Strock in 1939. The prosthesis connection to be applied then is provided to special protrusions on the implant. It may also be in the form of an implanted plate (35,36).

Co-Ni-Cr-Mo alloy is used as prosthesis material in hip and knee joints, which carries heavier loads than CoCrMo alloys.

Cobalt-based alloys used as orthopedic prosthesis are called Vitallium and contain about 30% chromium and 5% molybdenum

Figure 13. Metal Knee Prosthesis

Co-Cr alloys are divided into 4 types according to the practices of the surgeon. These are,

- Co-Cr-Mo (ASTM F75)
- Co-Cr-W-Ni (ASTM F90)
- Co-Ni-Cr-Mo (ASTM F562)
- Co-Ni-Cr-Mo-W-Fe (ASTM F563) alloys

Figure 14. Co-Cr-Mo,(b).Co-Cr-Mo-Ti hip prosthesis

Table 14. Chemical composition of Co-Cr alloys

ALLOY / ELEMENT	CoCrMo (ASTM F75)		CoCrWNi (ASTM F90)		CoNiCrMo (ASTM F562)		CoNiCrMoWFe (ASTM F563)	
	min.	max.	min.	max.	min.	max.	min.	max.
Cr	27,0	30,0	19,0	21,0	19,0	21,0	18,00	22,00
Mo	5,0	7,0	------	-----	9,0	10,5	3,00	4,00
Ni	-----	2,5	9,0	11,0	33,0	37,0	15,00	25,00
Fe	-----	0,75	-----	3,0	-----	1,0	4,00	6,00
C	-----	0,35	0,05	0,15	-----	0,025	-----	0,05
Si	-----	1,00	-----	1,00	-----	0,15	-----	0,50
Mn	-----	1,00	-----	2,00	-----	0,15	-----	1,00
W	-----	-----	14,0	16,0	-----	-----	3,00	4,00
P	-----	-----	-----	-----	-----	0,015	-----	-----
S	-----	-----	-----	-----	-----	0,010	-----	0,010
Ti	-----	-----	-----	-----	-----	1,0	0,50	3,50
Co	Remain							

Cobalt (Co) and chromium (Cr), which are basic alloying elements in Co-Cr alloys, provide about 65% Cobalt (Co) contribution to increase corrosion resistance against alloy solutions. With the addition of molybdenum (Mo) the thickness and mechanical properties of the material is increased. Increasing the chromium content further increases the corrosion resistance to solid solutions of the alloy. The Co-Ni-Cr-Mo (F562) alloy contains about 35% Cobalt and 35% Nickel (36).

Figure 15. Orthopedic Metal Prosthesis Materials

3.2.3 Titanium and Titanium Alloys (ASTM F 67 and ASTM F 136)

Titanium has been used as biomaterial since 1930. One of the important features of Titanium is being slight, as well as its mechanical and chemical properties, for biomaterial applications. The properties of titanium, such as inert nature, non-toxic structure, antimagnetic properties, lightness, good mechanical properties, production of small size specimens, resistance to corrosion, closeness to bone of its elasticity module have featured the usage as biomaterial in orthopedic and dental applications (36).

Figure 16. Metal-ceramics dental implant and prosthesis

Although titanium processing technology is expensive and costly, because of its superior properties it has many areas of usage, such as aviation, space, aircraft, medicine (hip and knee prosthesis, heart valve, dental implants etc.), hand tools and even golf clubs.

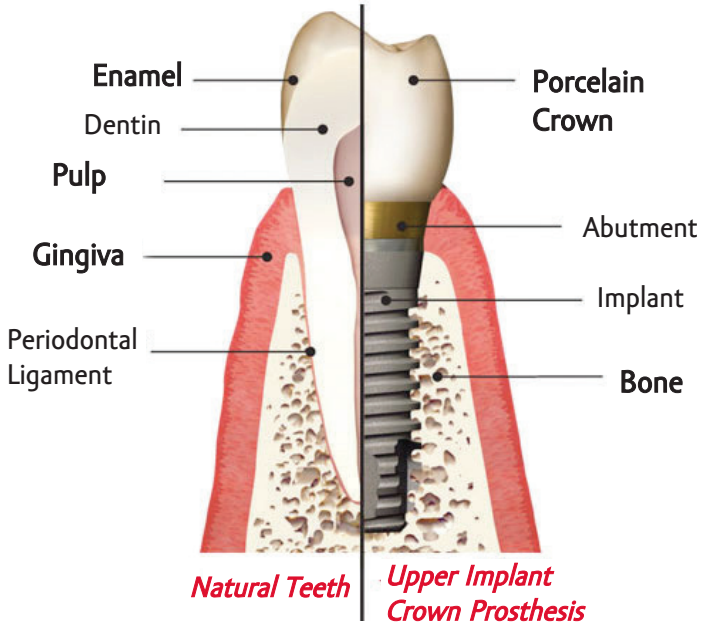


Figure 17. Dental Implant and prosthesis applications

Titanium and alloys that are superior in terms of physical and chemical properties are lighter than 316 stainless steel and cobalt alloys; a significant increase in medical and dental applications is seen in recent years. Today, titanium and its alloys are used extensively in the manufacture of joint prostheses, surgical supports, vasodilator stents and connectors, dental implants, crowns and partial prostheses. Endosteal implants are made from pure or alloyed titanium in different ways. The inert effect of the oxide layer on the surface of the implant allows the physiological fluid, protein, hard and soft touch to better understand the metal surface. Titanium, which is very well attached to the bone and have high acceptance in tissue, becomes part of the body after being placed.

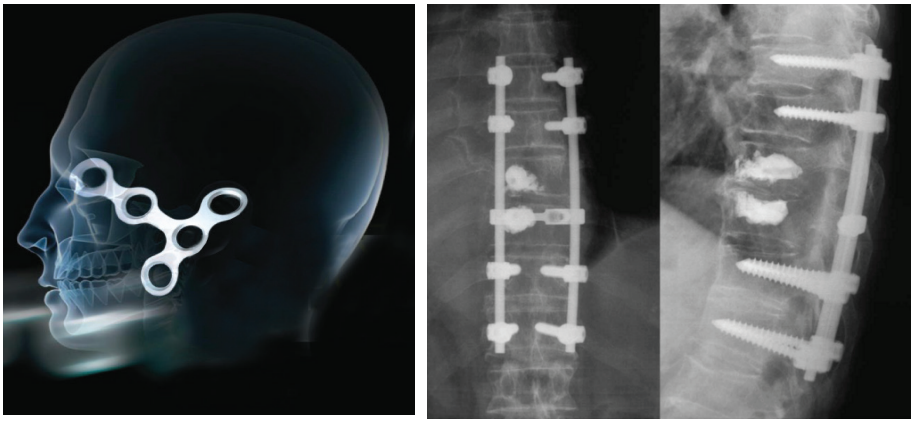


Figure 18. Metal Implant and Prosthesis

Cranium plate system, Micro plate system, Spine screws, fasteners as cannulated screw; skull, backbone, skeleton, are used for fixation of broken hand and foot bones and are produced from Ti-6Al-4V alloy.

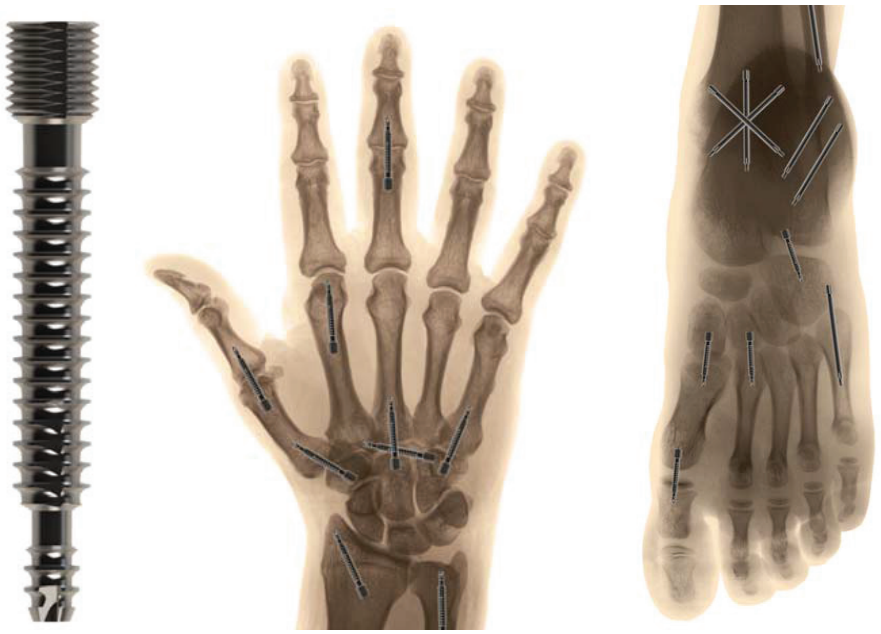


Figure 19. Cannulated Screw Connections

Table 15. Filler, Implant and Prosthesis Material Densities

MATERIAL	DENSITY (g/cm^3)
TITANIUM and ALLOYS	4.5
316 L STAINLESS STEEL	7.9
CoCrMo	8.3
CoNiCrMo	9.2
NiTi (NITINOL)	6.7
NICEL	8.9
GOLD	19.3
PLATINIUM	21,45
MAGNESIUM	1.74
AMALGAM	11.6
CHROME	7.19

3.2.4 Nikel (Ni)

3.2.4.1 General Use Areas

Nickel is a necessary element of modern life. Many metals and equipment combinations in the vicinity contain nickel. Coins, kitchenware, jewelry, keys, scissors, knives, needles, typewriters, various auto parts, watches and metal band etc. contain nickel. Nickel is used as an anti-rust and anti-corrosive coating in metal plating industry, in the production of non-corrosive steel, in dentistry and as a prosthetic material in the body together with chromium alloy.

Non-original chromium, nickel, cobalt-containing metal alloys and stainless-steel applications used in dentistry currently reach up to 90%. The use of nickel-based metal alloys in dentistry and orthopedics as prosthesis or implant materials has also caused some health problems. Most of the metals used in dentistry are known to be allergenic. Nickel is the most allergic of these. This metal has a tendency to store in the epithelium. The amount of nickel in human spit can range from 0.8-4.5 mcg / L. The rate of corrosion of alloys in the mouth is largely dependent on local factors. Oxygen, chlorine, phosphoric acid and lactic acids occasionally cause corrosion in the mouth flora. The resulting corrosion products lead to body fluids, and nickel-sensitive people, cause spots in various parts of the body, spreading to tissues around the prosthesis, inflammatory reactions in soft tissues and various skin diseases (39,40).

The ingestion and spread of allergens causes allergic disorders. Breathing of these substances may cause disorders, such as bronchitis and asthma, and taking them through the skin cause various skin disorders. If the allergen is interfered with circulation, it causes the clinical diseases in the body. Allergic reactions and other diseases observed in nickel sensitive patients can be explained by the appearance of nickel in the alloys used. Allergic diseases usually begin with an eczematous reaction in the area of contact with the metal. **Nickel dermatitis** composes % 5-12 of eczema diseases that occur in the human body. Approximately 3 in every 10 people have been found to be sensitive to nickel. Women are more sensitive. For this reason, it is necessary to pre-test patients for the use of chromium-nickel alloys and takes precautions to prevent sensitive people from using products made from these alloys.

3.2.4.2 Nickel - Titanium Alloys, Nitinol

These alloys are shape memory metals that have the ability to turn to their original shape when heated. Shape memory effect is used in biomaterials applications, in vascular occlusion, in dental bridges, in vessel connections in the skull, in artificial muscles for heart and orthopedic prostheses. These alloys exhibit shape memory effect at certain temperatures. The porous structure formed in Ni-Ti shape memory alloys has an important application area in biomedical technology due to its compatibility with the human body. The Ni-Ti alloy is used artificially in the human body as well as in surgical implants of hard tissues.

This alloy consisting of nickel and titanium (51% Ni and 49% Ti), which exhibits shape memory due to temperature after deformation is called Nitinol (38).

3.2.4.3 Studies on Nickel

It has been observed that 8-12% Nickel alloyed **Wain-Wright** plaques implanted in the hip are observed to cause **dermatitis** and abscess around plaque in various parts of the skin (39).

Experimental studies have reported that nickel dissolution occurs around the implant and nickel is distributed in the body (40).

Investigations intravenously administered nickel with autoradiography showed accumulation in the lung, brain and deeper (41).

Nickel alloys used as dental prosthesis materials have been examined and it has been suggested that dental cast alloys with more than 1% nickel should be used with caution because of the higher tendency of dermatitis initiation due to more corrosion of nickel alloys (42).

It has been suggested that the presence of nickel ions in metal alloys that are immersed in artificial saliva, due to corrosion, should be used with extreme caution in dental use (43).

3.2.5 Amalgam

The alloy which one of its components is mercury is called amalgam. Amalgam fillings used for 150 years are also known as silver fillings. The mercury which forms 45-50% of the mixture form a durable filler material by binding metals together.

Due to its mercury content, it is in liquid phase at room temperature and is used as a hard and durable alloy to fill a cavity with other metals such as silver, tin, zinc. Recent studies have reported that the mercury released into the body from amalgam fillings cause permanent brain, kidney and immune system damage in children. The release of mercury from fillings was reported to be 2-15 micrograms per day in adults. In the first studies on the side effects of mercury, it was observed that symptoms such as digestive system, sleeping pattern, concentration, memory problems, instability, uneasiness, gingival bleeding and other oral diseases were related to amalgam fillings. Because of the harmful health effects of the mercury, the use of amalgam in the world today is still being discussed even though it is banned in countries such as Canada, USA and Australia, Denmark, Sweden, Finland, Italy (37,44,45,46).

3.2.6 Gold (Au)

Gold and gold alloy is a precious metal used for dental longevity, durability and corrosion resistance. The minimum rate of gold in gold alloys is 75%, and the rest can be metals such as zinc, copper and platinum. Platinum and copper increase the strength, zinc lowers the melting temperature. However, if more than 4% is added, the melting temperature of the alloy increases and it becomes difficult to process. By adding a small amount of zinc, the melting temperature is reduced. Soft alloys containing more than 83% of gold are used as filling material, while alloys containing less gold are used as coating materials due to their hardness and strength (37,46).

3.2.7 Tantalum (Ta)

The elastic module of the tantalum is close to the elastic module of the bone. Not affected by body fluids, resistance to corrosion and biological compatibility are very good. It is an implant material that is used for excessively porous construction. The mechanical strength is low. Its high-density limits usage areas. It is mostly used as catgut in plastic surgery.

3.2.8 Platinum (Pt)

Platinum is a precious metal with high corrosion resistance. In dentistry, platinum is used as palladium + platinum, iridium + platinum alloys and electrodes in the body (37).

3.2.9 Magnesium (Mg)

Generally, implanted plant materials need to be removed after a period of time, especially in young patients during the adolescence. Otherwise, implants are an obstacle to growth. This requires a second operation. For this reason, magnesium alloys are being developed in the human body as a metal with good mechanical properties, biocompatible and melting in time. (Ankara Development Agency Project Market 2014).

Figure 20. Metal and ceramic implant and prosthesis

3.2.10 Ceramics and Glasses

Ceramics are used as dental fillings, gold porcelain crowning and prosthesis parts. The most commonly used ceramics are glass-ceramics containing alumina (Al_2O_3), Zirconia (ZrO_2), Calcium-Phosphate [$Ca_5(PO_4)_3OH$], Glass and Lithium / Aluminum or Magnesium / Aluminum. Alumina with high density and high purity (> 99.5%), because of its corrosion resistance, high strength and good biocompatibility, larynx is used in hip prosthesis and dental implants.

The alumina used in these applications is acquired in a sintering of the polycrystalline alpha-Al $_2$ O_3 with coarse grained structure at the temperature of 1600-1700°C. Alumina is used in orthopedic applications for 20 years.

Zirconia also has an inert effect on the physical environment, as alumina. Zirconium, which has much higher cracking and bending resistance, is successfully used in thigh-bone prosthesis. However, there are three major problems in practice: decrease of tensile strength because of physiological fluids over time, poor crowning properties and potentially radioactive materials limit its applications.

Calcium phosphate-based bio ceramics have been used for 20 years in medical and dentistry. These materials are used as "bone dust" in orthopedic coating, dental implants, face bones, ear bones, hip and knee prosthesis. The sintering of calcium phosphate ceramics takes place generally at 1000-1500 ° C and is followed by the desired condensation.

The glasses are silica (SiO_2) based materials. Glass ceramics are glasses containing (Li / Al) Lumin / Aluminum or (Mg / Al) Magnesium / Aluminum crystals. In my bio glass, some of the silica groups have been replaced by calcium, phosphorus, or sodium (SiO_2, Na_2O, CaO, P_2O_5). Thus, chemical bonding occurs between the tissue and the implant. Bioactive glasses were first developed by Hench and his friends. (34, 37).

3.2.11 Composites

Since the tissues are usually divided into two groups, strict as bone, teeth, or soft tissues such as blood vessels, skin and muscles, metals and ceramics may be compatible with strict tissues and polymers with soft tissues. However, in most cases metal and ceramics are tougher than textiles, in this case fiber-reinforced polymeric composite materials are expected to be used widespread in the future. Carbon, glass, kevlar fibers are combined with polymer materials to obtain high strength, low elastic modulus composite materials. In addition, since polymeric composites do not have a magnetic property, they are compatible with imaging systems such as Magnetic Resonance and Tomography. Composite materials have made great progress in today's technology due to their high strength and light weight (34).

3.2.12 Polymers

Polymers used in medical applications such as Polyethylene (PE), Polyurethane (PU), Polytetrafluoroethylene (PTFE), Polymethylmethacrylate (PMMA), Polyacetal (PA), Polyethylenenaphthalate (PET), Silicone rubber (SR), Polysulphon (PS) and Polyglycolic acid (PGA) have a wide range of applications as biomaterials because they can be prepared in a wide variety of compositions and forms (fiber, film, gel, beads, nanoparticles). However, for some applications, for example, their mechanical strenght in the orthopedic area may be weak, swelled in the form of liquids, or secrete undesirable toxic by-products (monomers, antioxidants). More importantly, sterilization processes (autoclaving, ethylene oxide, Co radiation) can influence polymer properties (34,37).

3.3 NEW DEVELOPMENTS AND R&D STUDIES

Biomedical Engineering has many work areas that can be catagorized. Some of those are; Clinical Engineering, Biomaterials, Biomechanics, Tissue Engineering, Bionics, Genetic Engineering, Neural Engineering, Artificial Organ and Rehabilitation Engineering.

With the development of materials for nano-measurement, especially in micro surgery, medical instruments, artificial organs and robots, new treatment techniques have started to be applied in diseases. For example, in chemotherapy, drugs placed in nano-sized capsules instead of whole body drugs may be delivered to the cancerous area through the veins, and without any side effects the treatment of the cancerous area only may be possible. Coronary artery occlusion treatment has also been started with the help of shape memory alloys that change its shape in the vein similarly.

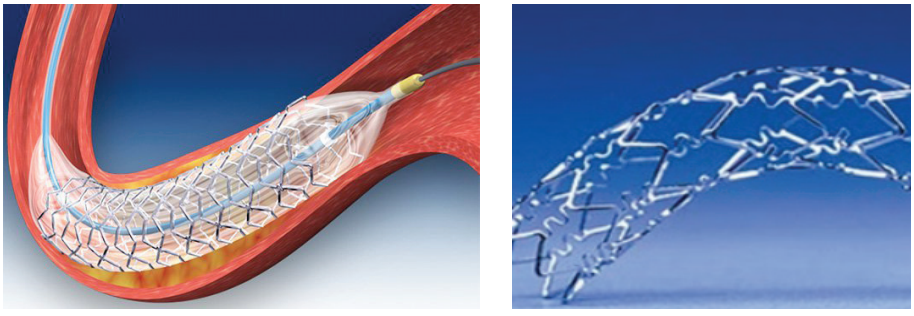


Figure 21. Shape memory alloys and meltable stent in veins

With particles produced at the nano level will give clearer images of the baby on the mother's womb.

Study on artificial organ production through bioengineering is ongoing on the one hand, while human tissues and organs that have begun to be produced with 3D technology on the other side are hopeful for many people.

From the 1980s, when 3D printers were invented, major developments in printing technology have been carried out and live tissue production with the first 3D printer started at Novagen 3D Printing Technology in 2009. As the tissue prints can be taken only in advance, organ prints can now be taken. In the production of bone and cartilage, which is the most used area of 3D bio-printer, more and more successful results have started to be achieved day by day. Nowadays, a cranium implant, which is made of special and durable plastic material with the help of a 3D printer, was created by Dutch scientists was placed in a 22 years old patient with bone disease. In 2015, in the same year a titanium cranium produced with a 3D printer by doctors in China transferred to a three-year-old girl, a titanium rib cage transferred to a 54-year-old cancer patient in Spain, and titanium jaw implants created by using 3D printing technology transferred to another patient in Australia due to cancer and titanium jaw transplant was carried out in Australia to other patient. (Figure 22).

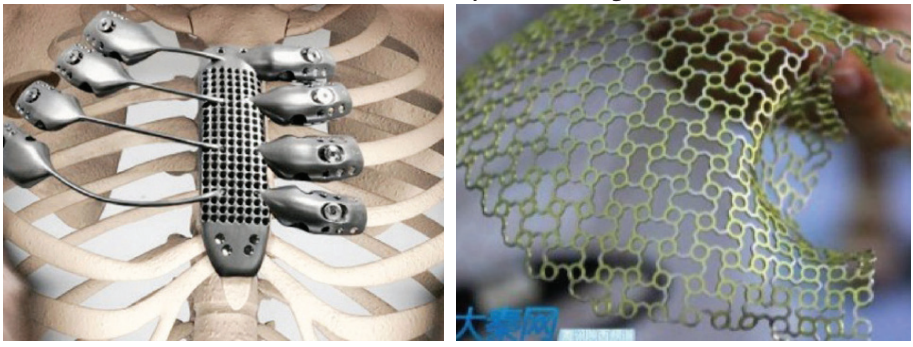


Figure 22. Titanium rib cage and cranium applications

It is stated that the bone prosthesis industry in the US has a very high potential, and that 300 to 500 patients only in this country can be treated with 3D printer-made cranial prosthesis transplant every month.

With the special tissue cells according to the structure of the stem cell and the organism to be produced in the special cartridges used in 3D bio printers, living tissues and organs such as human skin, ear, nose and face can be produced.

In the treatment of paraplegic diseases, investigations on the provision of hand, arm and leg movements with thinking power are continued by transferring signals with a certain interface software of prosthesis through the nervous cells going from the brain to the arms and legs.

Successful results have been obtained in studies on porous bioactive, silicon-based biomaterials that support cell adhesion and growth for repair of soft and cartilaginous tissues.

Alloys with Ni-Ti shape memory have been used in the orthopedic field as well as in stent production (Figure 21). When the Ni-Ti plates screwed to the broken bones reach the body temperature, provide bonding between the fractured bones by forcing and tightening.

In addition, many applications as smart contact lenses (polymethyl methacrylate or silicone), (Fig. 23), meltable polymer stents (Fig. 21) in a while after being transferred to heart vein,

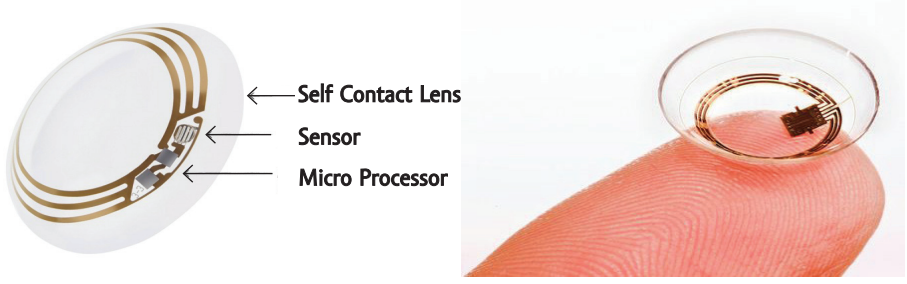


Figure 23. Smart Contact Lenses

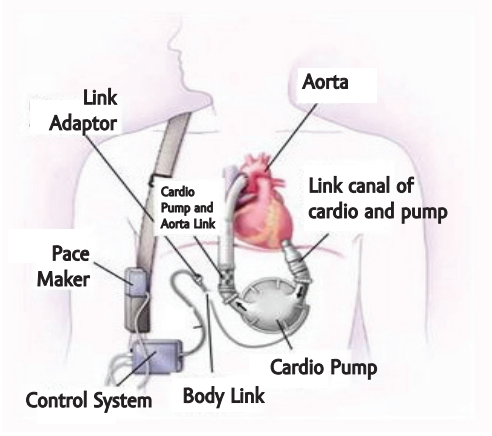


Figure 24. Artificial heart pumps

artificial cardio pump (Figure 24), pace maker (Titanium and polymer) and cardiac valves (Figure 25), portable artificial kidneys (silicone), artificial eye equipped with selenium cell (optical fiber, electrode, camera), fix and solution techniques of the problem in organs with smart capsules sent into the body by microprocessor and wireless high frequency transmitter, external skeletal system for paralyzed patients, artificial spinal cord disc, artificial tissue, artificial organs have been developed.

Figure 26. Heart Valve

The most commonly used artificial cardiac valve in the valves is the Starr Edwards valve. This valve with a ring at the base has either a sphere made of silicon or a metal grid with a hollow metal sphere. A hard, non-reactive alloy consists of cobalt, chromium, tungsten, molybdenum and iron are used in the metal cage construction.

New treatment methods and robotic applications will be developed by placing artificial organs, microprocessors, sensors, nanometer-sized materials developed with new technologies in the near future into the body.

4. ADDITIVE AGENTS USED IN FOOD

4.1 Introduction

Today around 80000 chemicals are used for various purposes in the world and this number is increasing every year. At the beginning of the 20th century only a few thousands of chemical substances were used, mostly of natural origin. However, the use of chemical substances has increased rapidly throughout the world, especially after the 1940s. World chemical production, which was 7 million tons / year in 1950, increased to 250 million tons / year in 1985. Today, this figure is about 400 million tons per year. Human health and the environment have suffered a great deal of damage due to the increasing number of diseases and untreated use of so many chemical substances, and they continue to be damaged.

Today more than 2000 chemical additives are allowed to be used in the food industry for different purposes, and its use has been determined in many countries by legal regulations to protect human health.

For the past 30 years, there has been a complete explosion of additives used in the take home food sector, especially in developed countries. For example, it is believed that the total weight of additives used in the UK in a year exceeds two hundred thousand tons. As consumption of these substances increased, findings for some diseases also began to emerge. The most common diseases are eczema, asthma, migraine, headache, allergies, gastric disturbances, cancer, diarrhea, hyperactivity and hypersensitivity etc.in children. Today, England have the sickest people compared to countries in Europe and the number of cancer cases in this country is at the top of the world.

In recent years, one of the most controversial issues, especially concerning consumer rights, is the food additives used in fabricated ready-to-eat food products we have consumed every day.

4.2 The Importance of Food Additives in Health

Additives are usually chemical substances, but substances such as fat, carbohydrates and minerals, which are found in foods and are essential for our lives, in other words foods themselves are also made up of chemical substances. Among these substances, there are contaminants contaminating foodstuffs and food additives which are added intentionally for specific purposes, except for the substances mentioned above and naturally found in the structure of food. Contaminants are toxic substances such as undesirable trace elements, heavy metals, aflatoxins, nitrosamines, etc. in food and studies are being conducted to prevent the ways of transmission and the limits to be found in food are determined by law. Food additives are additives which are allowed to be consumed according to certain purposes and the limits of use of these substances are regulated by studies at international level.

For this purpose, the Codex Alimentarius Commission (CAC) established by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) and the Joint Expert Committee on Food Additives (JECFA), a subcommittee of food additives of this institution, is making studies about the safety of food additives on human health and is preparing lists of substances determined to be safe for use at certain doses. Thus, other countries regulate lists of additives that are allowed to be used in their country based on these lists. Food additives which are considered suitable for use in our country are carefully selected by making use of these lists created by CAC and EC.

Both the CAC and the European Community (EC) have established important rules for the use of food additives.

Toxicological evaluations are currently being applied to all food additives currently in use or recommended for use and all side effects that may arise from the use of food additives are being examined.

In all the studies carried out untill this time, only the additives which do not harm the consumer health were allowed to be used. All additives should be kept under constant control and re-evaluated if necessary in accordance with new scientific discoveries. There is also a need for new legislation to prohibit the use of food additives that have been proven harmful to health and prohibited in many countries,

and to prohibit the promotion and sale of suspicious products with excessive use of harmful additives (50).

4.2.1 Food Additives and Allergies

A large number of substances present in the environment and in the nutrients can cause allergic reactions. Some of the food additives, such as those found in the naturally occurring structure of foods, can also cause allergic reactions in individuals. The basic principle of allergy prevention is to determine the factor that causes the allergy in person and to stop contact with it. This principle applied for food allergens for environmental allergens and allergens found in the natural structure of nutrients is also acceptable for food additives. It is an obligation to find the additives in the food packaging in written and it facilitates this .

Some people may show allergic reactions to additives. As it can be understood from this information, it is necessary to discuss the food additives in our country meticulously as it is in all the developed countries in the world and it should seriously be inspected by legal institutions. The first most important issue of three to be considered under the supervision of food additives permitted to use is that these substances are in food purity, the second is that they do not exceed the limits allowed in food, and the third is shelf life. This can only be done by establishing an effective laboratory control system in the country

4.2.2 Food Additives and Cancer

Our nutrition habits trigger the formation of cancer. In today's lifestyle, food additives have become a part of our nutrition. While some of the additives have a carcinogenic effect, some of them increase the effectiveness of the carcinogens. Carcinogens are not allowed to be used in nutrients. If these effects are not known when permitted and is it is understood later they should be forbidden to use immediately. For example, some synthetic additives, such as dulcin, cinnamyl anthranilate and thiourea were found to cause liver cancer by experiments, and the use of these substances in foods was prohibited. Sodium nitrite (E250) or potassium nitrite (E249), which are nitrite salts, can be given as examples of substances that increase the risk of cancer. They are added as antibacterial as a coloring agent to processed meat products such as sausages and fermented sausages. Consuming 50 grams of processed meat products every day increases the risk of getting bowel cancer by 21% (51).

4.2.3 Food Additives and Hereditary Diseases

Some substances naturally found in nutrients can be harmful to patients. If some of these natural substances are present in food additives, the ADI (Admissible Daily Use) practice will be insufficient to protect these patients. Some important inherited disease groups related to nutrients are given below.

4.2.3.1 Phenylketonuria Inherited Disease

An amino acid, phenylalanine, is converted into tyrosine by the phenylalanine hydroxylase enzyme in the organism. In the absence of this enzyme, phenylalanine accumulates in the stomach and tissues. Ultimately, a damage can occur to various organs, including the brain. Phenylketonuria should be identified and removed from the nutrients.

4.2.3.2 Celiac Disease

A gluten which is a protein found in grains such as wheat, barley and rye, causes damage called **gluten enteropathy** (impaired absorption) in gluten genetic disease.

4.2.3.3 Hemochromatosis (Abnormal Accumulation of Iron)

It is a genetic disorder characterized by the absorption of iron in excess amounts of nutrients. The accumulated iron may develop toxicity by cumulating in the liver, heart, pancreas and some other organs.

4.2.3.4 Wilson's Disease (Autosomal recessive inherited disorder of copper metabolism)

Organism is a genetic disease characterized by **copper accumulation**. The main organ targeted in the toxicity due to cumulation of copper is liver.

4.2.4 Food Additives and Other Diseases Caused By

The most commonly used additives and the main diseases they cause are:

4.2.4.1 Aspartame (E951)

It is a substance found in many nutrients and beverages as a sugar substitute instead of sugar. Aspartame consists of a mixture of 40% aspartic acid, 50% phenylalanine and 10% methanol.

Aspartame is one of the most blamed additives in terms of side effects. These are itching, rash, headache, dizziness, nausea, drowsiness, muscle spasms, exhaustion, depression, respiratory distress, palpitations and various allergic events.

4.2.4.2 Benzoic acid (E210-E211)

It is an additive, especially found in processed foods. It is added to nutrients such as chocolate, various fruit juices, candies, margarine, ice cream, creams, sauce, ketchup, gum, etc. Benzoic acid can cause a variety of allergic reactions such as asthma, migraine, skin rash. People with aspirin allergy should be more careful.

4.2.4.3 Food dyes

Artificial food dyes are used to give color to the nutrients. These are named with numbers such as E110, E102, E123, E131, E142. Some food dyes, some nutrients such as, cakes, candies, canned foods and vegetables, cheeses, chewing gum, sausage, ice cream, fruit drinks, salad sauces, ready-made salad sauces, non-alcoholic drinks and ketchup include tartrazine. People who are sensitive to this substance may experience rash or asthma attacks with very rare occurrence. Artificial food dyes affect the human brain and cause hyperactivity, especially in children. E123 and E110 are prohibited in many countries of the US and Europe.

4.2.4.4 MSG ve Glutamat

Mono Sodium Glutamate (E621) is a spice with its unique taste, especially used in Far East Chinese cuisines. This reaction is called "Chinese Restaurant Syndrome". Many manufacturing plants and restaurants use as flavor enhancers in various foods. MSG cause complaints such as Headache, nausea, diarrhea, sweating, chest tightness, burning sensation in the forearm, behind the head and neck, numbing or tingling on the face or head, on the arms and legs, chest pain or compression, palpitations, nausea, diarrhea, sweating. Allergic reactions may occur due to excessive stimulation of the nervous system and may also trigger neurological diseases such as Alzheimer's and Parkinson's. Such reactions occur after excessive MSG removal. In asthmatics patients who consume this substance, severe asthma attacks can occur.

4.2.4.5 Nitrate / Nitrites (E249-252)

These two substances are used both as a preservative and as a coloring and flavor enhancer. Nitrates and nitrites are especially added to processed meat products such as sausages, salami and fermented sausages. It can cause headache and hives in some people. They can form nitrosamine causing cancer and reduce the ability of the blood to transport oxygen.

4.2.4.6 Parabens

Parabens are used as preservatives in nutrients and medicines. Methyl, ethyl, propyl, butyl paraben and sodium benzoate are examples thereof. When taken in the body, sensitive to these substances can cause severe skin signs or skin rash, swelling, itching and pain.

4.2.4.7 Tartrazine (E102)

It is an additive used to give nutrients and drinks a yellow color. Non-alcoholic beverages, ice cream, candies, puddings, spaghetti are the main foodstuffs. They cause skin rashes and asthma attacks. In aspirin allergy sufferers, asthma crises are very severe and resistant to treatment. (52).

4.2.4.8 Sulfites (E220-E228)

Sulphidation agents are also known as sulfur dioxide, sodium or potassium sulphite, bisulphite, metabisulphite.They are used as food preservatives and fermented beverage containers. They are found in baked goods, biscuits, wafers, cakes, teas, seasonings, seafood, biscuits, jams, dried fruits, juices, canned and dehydrated vegetables, chips, frozen potato and soups, beverages such as beer and wine. Sulphides can cause discomfort such as tightness in the neck, hives, cramps in the back, diarrhea, blood pressure problems, burning sensation, fatigue, accelerated pulse. In addition, sulphites may also trigger asthma in susceptible asthmatics.

4.2.4.9 Carmine Red

It has been used to give a pink, red, purple color to many nutrients, beverages, medicines and cosmetics for hundreds of years. Carmine red is considered a natural additive material since it is not a synthetic dye but is obtained from an insect. Carmine red is known as substance that causes anaphylactic shock to go from death to simple rash and itch (53).

4.2.4.10 Cyclamates (E952)

It is an artificial sweetener used in diet nutrients. It is banned in the United States for causing cancer.

4.2.4.11 Sodium Guanylate (E627), Sodium Inosinate (E631)

It causes the intensification of gout disease. It should not be used in low-purity foods. Processed meat products are found in bouillon cubes, soy nutrients, instant soups.

4.2.4.12 Potassium Bromate (E924)

This additive is used to increase the volume in bread and floury foods and to create a more beautiful bread structure. Bromate causes cancer in animals. Bromate is prohibited all over the world except the US and Japan.

4.2.4.13 Propyl Gallate (E310)

This contraceptive is used to prevent degradation of fats and oils. It is used as a preservative additive in vegetable oils, meat products, sliced potatoes, instant soup and gum. It is mostly used with butyl hydroxyanisole (BHA) and butyl hydroxy toluene (BHT) additives. It can cause cancer. It can cause gastritis and skin irritation and is not allowed to be used in infants and small children 's food because it harms the hemoglobin present.

4.2.4.14 Butylated Hydroxyanisole / Hydroxytoluene (E320 BHA / E321 BHT)

Butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are used to prevent molding and fouling of oils and fats. It is used in some packaged food products to preserve its properties in cereals and products, gums, vegetable oils, potato chips. In some studies, it has been observed that this additive causes cancer in rats. It is not allowed to be used in baby foods, it may cause allergic reactions, hyperactivity, carcinogens, estrogen effects and other diseases. If there is information that this additive is used on the nutrients consumed, preferring of other branded products will be more appropriate in terms of health protection.

ANNEX.1: ADDITIONAL INFORMATIONS CONCERNING ELEMENTS AND HEALTH

Nail Analysis

Symptoms such as **iron deficiency and anemia**, skin pale appearance, fatigue, lack of attention, hair splitting, nails take a spoon shape and weak nail structure appear. Nail fractures are most often caused by circulatory system related anomalies and iron deficiency anemia.

A healthy person's nails are pink and normal. It is strong, durable, flexible. It is not easy to break. For this reason, the easily broken, slow-growing nails are considered to be the most obvious signs of **lack of calcium** in the body. Too much selenium causes nail breakage.

Hard, but quickly broken nails can be a sign of calcification. In addition, cleavage of the nails, up taking in layers may be due to insufficient function of some hormones and vitamin deficiency. Excessively bright nails are also seen as a symptom of a patient's abnormal functioning thyroid gland. Excessive pale fingernails may be a symptom of anemic,those with too much redness may be symptoms of blood circulation disorder, purple nails may be an organic heart disease, or lung disease. Nails ranging from dark yellow to brown also indicate kidney disease.

The white spots on the nail are actually caused by exhaustion and zinc deficiency.

The red lines seen in front of the nail edge are considered as an organic condition, the white lines are considered a sign of heart weakness. Thickened nails indicate cutaneous disease,red spots indicate diabetes,pale and yellowed nails indicate anemia,whiteness is liver disease as hepatitis,yellow and slow-growing nails indicate irritation of the lungs, yellow-colored and bottom-spotted nails indicate diabetes mellitus, half-pink, half-white nails also indicate kidney disease.

If the nail end is red, this can indicate heart disease. If the nails are gritty or peeled off, this may indicate rheumatism or arthritis.

Hair Analysis

The causes of many diseases such as suspicious poisonings, death cases, sudden changes in the body, Alzheimer's, etc. can be understood by hair analyses. Increasing levels of environmental pollution and intensive use of chemicals in the industry cause heavy metal toxicity and become a major threat to our health. High levels of toxic metals that accumulate in body tissues and in the brain can cause significant developmental and neurological damages.

Heavy metal testing is ideal for detecting heavy metal toxicity with hair-line analysis. Hair provides important data in the early diagnosis of toxic elements and deviations in body metabolism and physiological disorders. Extensive study has found that there is a relationship between the levels of elements in the barba and the systemic levels in the human body. Therefore, many researchers prefer barba for toxic element analysis.

Elements such as magnesium, chromium, zinc, copper and selenium are obligatory cofactors of important enzymes and are also necessary for normal functions of vitamins. The levels of these elements in the hair are related to levels in the organs and other tissues. Toxic elements can be 200-300 times higher in the barba compared to blood or urine specimens. For this reason, it can be detected by hair analysis when exposed to elements such as arsenic, aluminum, cadmium, lead, antimony and mercury.

To determine if there is heavy metal toxicity or element deficiency, to monitor the effects of heavy metal removal from the body, and to evaluate post-enhancement of important minerals, hair analysis is a helpful test.

Table 16. Blood, Plasma and Serum Analysis

Element	Sample	Traditional Unit	SI Units
Copper	Serum	70–155 mcg/dL	11–24.3 mcmol/L
Calcium	Serum	8.2–10.5 mg/dL	2.15–2.5 mmol/L
Chlorine	Serum / Plasma	98–110 mEq/L	98–110 mmol/L
Iron	Serum	50–175 mcg/dL	9–31.3 mcmol/L
Magnesium	Serum Blood	1.3–2.1 mEq/L 1.6-2.6 mEq/L	0.62–1.2 mmol/L
Nickel	Blood Serum / Plasma	1-28 mcg/L 0.6-7.5 mcg/L	
Manganese	Blood Serum / Plasma	0.3–0.9 ng/mL 7.7-12.1 ng/mL	5.5–16.4 nmol/L
Zinc	Serum / Plasma	70–150 mcg/dL Min. 60 mcg/dL	10.7–18.4 mcmol/L 9 mcmol/L
Berylium	Serum / Plasma	01-4 mcg/L	
Silicon	Blood Serum / Plasma	1.2-8.9 mcg/L 0.4-10 mcg/L	
Selenium	Blood Serum / Plasma	58-234 mcg/L 46-143 mcg/L	
Aluminum	Serum	1-10 mcg/L	
Vanadium	Blood Serum / Plasma	0.1-17 ng/mL 0.02-1.3 mcg/L	
Titanium	Serum / Plasma	0.1-33 mcg/L	
Molybdenum	Blood Serum / Plasma	0.8-3.3 mcg/L 0.1-3 mcg/L	
Cobalt	Serum Blood	0.05-0.35 mcg/L 0.04-0.8 mcg/L	
I	Serum / Plasma	59-76 mcg/L	
Cr	Serum	0.1-04 mcg/L	
Sodium	Serum / Plasma	136–145 mEq/L	136–145 mmol/L
Potassium	Serum	3.5–5.1 mEq/L	3.5–5.1 mmol/L
Phosphor	Serum	2.7–4.5 mg/dL	0.87–1.45 mmol/L
Fluorine	Plasma	0.01-0.2 mcg/mL	0.5-10.5 mcmol/L
Mercury	Blood	0.6-59 mcg/L	≤0.29 mcmol/L
Lithium	Serum / Plasma	0.6-1.2 mEq/L	0.6-1.2 mmol/L
Cadmium	Blood	0.1-0.5 mcg/dL	8.9-44.5 nmol/L
Lead	Blood	< 25 mcg/dL	<0.48 mcmol/L
Arsenic	Blood	0.2-2.3 mcg/dL	0.03-0.31 mcmol/L

ANNEX 2: METALS AND ITS COMPOUNDS WHICH CAN BE FOUND MOSTLY IN METALLURGICAL AND CHEMICAL INDUSTRY WORKING AREAS

Arsenic and its compounds

The maximum amount that can be found in the environment in a working day for inorganic arsenic and its compounds is **0.01 mg/m^3**, the amount limited in a working day in state-affiliated industrial establishments in the US for soluble compounds **0.2 mg/m^3** (0.05 ppm). In Sweden, this value was determined to be 0.05 mg / m^3 for all arsenic compounds. Inorganic arsenic compounds cause death when taken orally in the body at concentrations above 60 ppm.

Aluminum and its compounds

The maximum amount of aluminum oxide per day is given as **10 mg/m^3** as powder or **5 mg/m^3** in respiration powder.

This amount is **2 mg/m^3** for aluminum alkaline.

Antimony and its compounds

Antimony and its compounds are highly toxic. Antimony compounds such as Sb2O3 and SbH3 can be up to **0.5 mg/m^3** or 0.1 ppm in a working day. Respiration into the living (air / dust containing antimony compounds) passes through eating, drinking and skin contact. In particular, SbH3 is a very harmful gas and directly destroys blood cells. **40 ppm** causes sudden death.

Barium and its compounds

For Barium and its compounds, the maximum amount of **0.5 mg/m^3** in a working day by the US health and safety agency was reported as **250 mg/m^3**, which could suddenly cause deaths. Barium chloride, nitrate and hydroxides are highly toxic.

Beryllium and its compounds

The biggest destruction that Beryllium has created in living things is the disease called **"Beryllium Disease"**. Beryllium and its compounds are chemicals that can exert a carcinogenic effect, and the collecting zone of the body is mainly the upper respiratory tract and lungs. The contact of fusible beryllium salts to the skin and mucous membranes, cause disorders such as painless ulcerations and burn-like acute dermatitis.

The effect of metallic beryllium is similar to other substances in the lungs that cause silicosis and fibrosis. The maximum concentration in air is given as **0.002 mg/m^3**.

Bromine and its Compounds

According to the United States Occupational Safety and Health Agency, the maximum amount of bromine that can be in the environment in a working day is **0.1 ppm**, the short-term exposure limit is **0.3 ppm**, and the immediate effect of vital effect is **10 ppm**.

Calcium Compounds

Calcium oxide has a strong burning effect for tissues. The amount that should not be exceeded in a working day is **2 mg/m^3**.

Chromium and its compounds

For chromium and soluble compounds, the required amount that should not be exceeded is **0.5 mg/m^3** in a working day, **0.05 mg/m^3** for chromates. Some of the chromium compounds cause skin diseases such as skin ulcer etc.

Cobalt and its compounds

Cobalt metal dusts and steam cause respiratory diseases. Irritant effect and allergic dermatitis are observed in the direct contact of cobalt and its salts with the skin and mucosa. The maximum amount that can be present as dust and steam in a working day is **0.05 mg/m^3**. The water-soluble cobalt compounds are redissolved 75% when taken orally, and the remaining cobalt is collected in the blood, liver, lung, kidney, testicles and intestines.

Copper and its compounds

Copper powders have been observed to cause lung, liver and pancreatic diseases in animal experiments. For this reason, it is recommended that copper powders should not exceed **1 mg/m^3** (U.S.A. and Russian Health Organizations) in the working environment within a working day, and maximum **0.1 mg/m^3** (U.S. Occupational Safety and Health Agency) for copper steam. The limit value announced by the World Health Organization in drinking waters is 0.3 mg / L (48).

Iron and its compounds

Iron dust can cause some eye diseases and tissue disorders that contain

iron. It should not exceed the amount of iron oxide of **5 mg/m^3** in a working day.

Lithium and its compounds

Metallic lithium is a highly reactive metal and presents a fire hazard when it is heated. Lithium oxide and hydroxide are extremely corrosive and lithium ions are toxic to the central nervous system.

Manganese and its Compounds

Manganese dusts and vapors generally occur during mining operations or in manganese reduction furnaces. It has been reported that it causes poisoning effects, upper respiratory disorders and central nervous system disorders. The maximum amount of tolerance is **5 mg/m^3** in the air.

Mercury and Its Compounds

Mercury and its compounds are generally poisonous. The greatest effects are on the central nervous system, teeth and gingivas. The number of mercurial compounds that should not be exceeded in a working day was given as **0.05 mg/m^3**.

Molybdenum and its compounds

It has been reported that it is **10 mg/m^3** for non-soluble molybdenum compounds and **5 mg/m^3** for soluble compounds utmost in a working day.

Nickel and its compounds

Nickel and its compounds cause allergy in the skin. For metallic nickel, the maximum amount that can be found in the environment in a working day is **0.5 mg/m^3** and for ferrous nickel compounds is **0.1 mg/m^3**. Among the nickel compounds, the most toxic is the nickel-carbonyl ($Ni[CO]_4$) compound. The presence of **30 ppm** of carbonyl carbonyl in the air is toxicant in 15-20 minutes. The amount of Nickel that can be present in the environment is **0.001 ppm**.

Silver and its compounds

Metallic silver causes **Argyria**'s disease. The amount of silver that can be found on the environment in a working day should not exceed **0.1 mg/m^3**.

Tin and its compounds

Metallic tin is not toxic. Some inorganic tin salts are highly irritating and alkaline tin compounds are highly toxic. Organic tin compounds go

through the skin. It is recommended for inorganic tin compounds should not exceed the maximum amount of **2 mg/m^3** in a working day and **0.1 mg/m^3** for organic compounds.

Uranium and its compounds

Uranium compounds are highly toxic. The maximum amount of soluble and insoluble uranium compounds that can be found in the environment is **0.2 mg/m^3**.

Vanadium and its compounds

The maximum amount that can be found as dust and steam in a working day is limited to **0.05 mg/m^3**.

Selenium and Its Compounds

The most toxic compound of selenium is hydrogen selenide and its maximum value is 0.05 ppm. The maximum value of other selenium compounds should be 0.1 ppm. The maximum value in the air in the USA is 0,2 mg/m^3. In Germany, the value limit is 0.008 mg / L in the drinking water and the maximum limit level is 0.01 mg / L

Tellurium (Te)

Tellurium occurs as a by-product during the processing of lead, copper, bismuth, precious metals and nickel ores and from sulfuric acid plants. The main source is copper anode mud. There is no harmful effect of tellurium concentration up to <0.01 mg/m^3 in air and <1 g / L in urine. The maximum atmospheric value for tellurium and its compounds are 0,1 mg/m^3.

Zinc and its Compounds

Zinc compounds are generally toxic at low levels. The maximum amount of zinc oxide vapor that can be present in the work environment is limited to **5 mg/m^3** (24,48,49).

ANNEX.3: FOOD ADDITIVES (FA)

Classification of Food Additives by European Union E Number System

Categories of the FA are indicated according to their intended use, by the following special names and "E (European)" numbers on take-home food packages. The "E" numbers have been introduced by the European Union countries as a practical coding method for FA. The "E" numbers and custom names make it easy for food product to be identified during their purchase.

Classification according to the basic functions of the FA with the number system "E"

1. Colorants E100-180
2. Preservatives E200-297
3. Antioxidants E300-321
4. Emulsifier and Stabilizers E322-500
5. Acid and base suppliers E500-578
6. Sweeteners, fragrances E620-637
7. For multipurposes E900-927

The areas of use of FA controlled strictly by the law are:

1. Colorants: Dyes and pigments are added to the nutrients to restore the natural colors that are lost during the processing of the food and make them attractive to the consumer.

E102** Tartrazine
E104 Quinoline Yellow
E107 Yellow 2G
E110** Sunset Yellow
E120** Karmin (Kokineal)
E122 Karmoisine
E123 Amaranth
E124** Ponceau 4R
E127** Erythrosine
E128 Red 2G
E129 Allura Red
E131 Patent Blue V
E132 Indigo Karmin

E133 Brilliant Blue FCF
E142** Green S
E151 Black PN
E154 Brown FK

2. Preservatives: It is added to prevent the microbial spoilage of nutrients and shelf life.

E210** Benzoic acid
E211 Sodium benzoate
E212 Potassium benzoate
E213** Kalsium benzoate
E214** Ethyl 4-hydroxybenzoate
E215 Ethyl 4-hydroxybenzoate sodium salt
E216 Propyl 4-hydroxybenzoate
E217 Propyl 4-hydroxybenzoate sodium salt
E218 Methyl 4- hydroxybenzoate
E219 Methyl 4- hydroxybenzoate sodium salt
E220 Sulphur dioxide
E221 Sodium sulphite
E222 Sodium hydrogen sulphite
E223 Sodium metabisulphite
E224 Pottasium metabisulphite
E226** Calcium sulphite
E227 Calcium hydrogen sulphite
E230 Biphenyl
E231 2-Hydroxybiphenyl
E232 Sodium biphenyl-2-yl oxide
E233 2-(Thiazol-4-yl) benzimidazole
E239 Hexamine
E249 Potassium nitrite
E250 Sodium nitrite

3. Antioxidants: It is used to prevent the spoilage and rancidity of oil.

ANTIOXIDANTS		
Number	**Name**	**Comment**
E300	Ascorbic acid	Antioxidant. 'Vitamin C' is obtained synthetically from glucose, found in natural vegetables and fruits, it is used in meat, bakery products, frozen fish products.
E301	Sodium ascorbate	Antioxidant. Sodium salt of vitamin C.
E302	Calcium ascorbate	Antioxidant. The calcium salt can accelerate the formation of **'Calcium Oxide'** stones.
E303	Potassium ascorbate	Antioxidant. Potassium salt of vitamin C.
E304*	Ascorbic palmitate,	Antioxidant. Fatty esters of ascorbic acid.
E306* **E307*** **E308*** **E309***	Tocopherols	Antioxidant. Vitamin E is found in the oil of many vegetables and animals such as soy, wheat, rice, cottonseed, corn, margarine and salad sauces it is used in pharmaceuticals and cosmetics.
E310	Propyl gallate	Antioxidant. It may cause gastritis and skin irritation, it is not allowed in infant and small child food because it harms hemoglobin in the blood, it is used in oil, margarine and salad sauce.
E311*	Octile gallate	See: E310
E312*	Dodecyl gallate	See: E310
E317	Erythorbate acid	Antioxidant. Produced from sucrose.
E318	Sodium erythorbate	Antioxidant.
E319	Tertiary butyl hydroquinone (TBHQ)	Antioxidant. Petroleum, HACSG[1] recommends avoidance, it may cause nausea, vomiting, numbness, a dose of 5 g is considered fatal, it is used in oils and margarines.
E320*	Butylated hydroxyl-anisole (BHA)	Antioxidant. It is used in petroleum, renewable oils, chewing gum, margarine, hazelnut, potato products and polyethylene foods, it is not allowed to be used in baby foods, it can cause allergic reaction, hyperactivity, carcinogen, estrogen effects and other adverse effects.
E321*	Butylated hydroxyl-toluene (BHT)	Antioxidant. See: E320
E322*	Lecithin	Antioxidant. Emulsifier. It is obtained from soybean oil, yolk, peanuts, corn or animal fat. It is used in margarine, chocolate, mayonnaise and milk powder, vegetable type should be preferred.
E325**	Sodium lactate	Antioxidant. Lactic acid salt. It's animal origin.
E326**	Potassium lactate	See: E325
E327**	Calcium lactate	See: E325
E328*	Ammonium lactate	See: E325
E329*	Magnesium lactate	See: E325
E330	Citric acid	Antioxidant. Food acids are naturally derived from citrus fruits, it is used in biscuits, canned fish, cheese and cheese products, baby food, cakes, soups, rye bread, drinks and fermented meat products.
E331	Sodium citrates	Antioxidant. Food acid.

E332	Potassium citrates	Antioxidant. Food acid.
E333	Calcium citrates	Antioxidant. Food acid.
E334**	Tartaric acid	Antioxidant. Food acid.
E335**	Sodium tartrates	Antioxidant. Food acid.
E336**	Potassium tartrates	Antioxidant. Food acid.
E337**	Sodiumpotassium tartrate	Antioxidant. Food acid.
E338	Phosphoric acid	Antioxidant. Food acid.
E339	Sodium phosphates	Antioxidant. Mineral salt, pharmacologically laxative, high doses can disrupt the calcium-phosphorus balance in the body
E340	Potassium phosphates	See: E339
E341*	Calcium phosphates	Antioxidant. Mineral salt is found in rocks and bones.
E343	Magnesium phosphates	Antioxidant. Mineral salt.
E350	Sodium malates	Antioxidant. Mineral salt.
E351	Potassium malates	Antioxidant. Mineral salt.
E352	Calcium malates	Antioxidant. Mineral salt.
E353	Metatartaric acid	Antioxidant. Food acid.
E354	Calcium tartrate	Antioxidant. Mineral salt.
E355*	Adipic acid	Antioxidant. Food acid.
E357*	Potassium adipate	Antioxidant. Mineral salt.
E363	Succinic acid	Antioxidant. Food acid. It is prohibited in some countries.
E365	Sodium fumarate	Antioxidant. Mineral salt.
E366	Potassium fumarate	Antioxidant. Mineral salt.
E367	Calcium fumarate	Antioxidant. Mineral salt.
E370	1,4-Heptonolakton	Antioxidant. It is prohibited in some countries.
E375	Niacin	Antioxidant. B3 vitamins are naturally found in beans, peas and other legumes, milk, eggs, meat, poultry and fish, in overdose it causes diabetes, gastritis, liver and eye damage and gut disease, it may cause elevated levels of uric acid, redness on the skin, especially on an empty stomach, it can cause head and stomach pain.
E380	Tri-ammonium citrate	Antioxidant. Mineral salt.
E381	Ammoniumferric citrates	Antioxidant. Mineral salt.
E385	Calcium disodium ethylene (EDTA)	Antioxidant. It is prohibited in some countries.

- Unmarked "black" E numbers indicate additives that are considered halal.
- "Red" E numbers indicate hazardous additives for health.
- "**" marks indicate contributions from certain animal (some pigs) additive.
- "*" may be of vegetable or animal origin. It may or may not have been treated with alcohol. For this reason, it shows the accepted suspicious contributions.

4. Emulsifiers and Stabilizers: Emulsifiers are used to mix water with oils. Stabilizers are used to stabilize emulsions and prevent them from being separated into their constituents.

Main Emulsifiers:

1. Lecithin
2. Fatty Alcohols
3. Mono- and diglycerides
4. Succinic Monoglyceride
5. Fatty Acids and Salts
6. Planta Emulsifier
7. Saponin

Stabilizers:

Stabilizers, also known as "hydrocolloid", "gum" (gam: gum) are substances with a wide variety of functions in nutrients. These are additives that are used to form the desired structure in the production of food products, to maintain or improve a certain structure.

Important Stabilizers Used in Food Industry:

Arabic Gum, Gummi tragacanthae, Karaya Gum, Arabinogalactan, Gatti Gum, Locust bean gum, Guar Gum, Agar, Alginic Acid,Carrageenan (Ca,Na and K salts, Forselan, Carboxymethylcellulose (CMC), Na-CMC, Methylcellulose and Hydroxypropylmethylcellulose, Hydroxypropylcellulose, Microcrystalline Cellulose, Xanthium Gum, Pectin, Jeletin, Amylum, Modified Amylums.

5. Sweeteners

A. A. Natural Sweeteners
B. B. Artificial Sweeteners

Important artificial sweeteners

1. Saccharin
2. Cyclamates
3. Aspartame
4. Dulcin
5. Acesulfame

6. Acid base suppliers (E500-578)

Acidity regulators are used to adjust the pH of the food, to balance the taste of food products, and to mask the unwanted taste of food. Acids mainly used in the food industry are acetic acid, citric acid, lactic acid, propionic acid, sorbic acid, succinic acid, adipic acid, fumaric acid, malic acid, tartaric acid and phosphoric acid.

7. Wide-ranging food additives (FA)

They are widely used food additives as flavor enhancers, solvents, polyphosphates, etc

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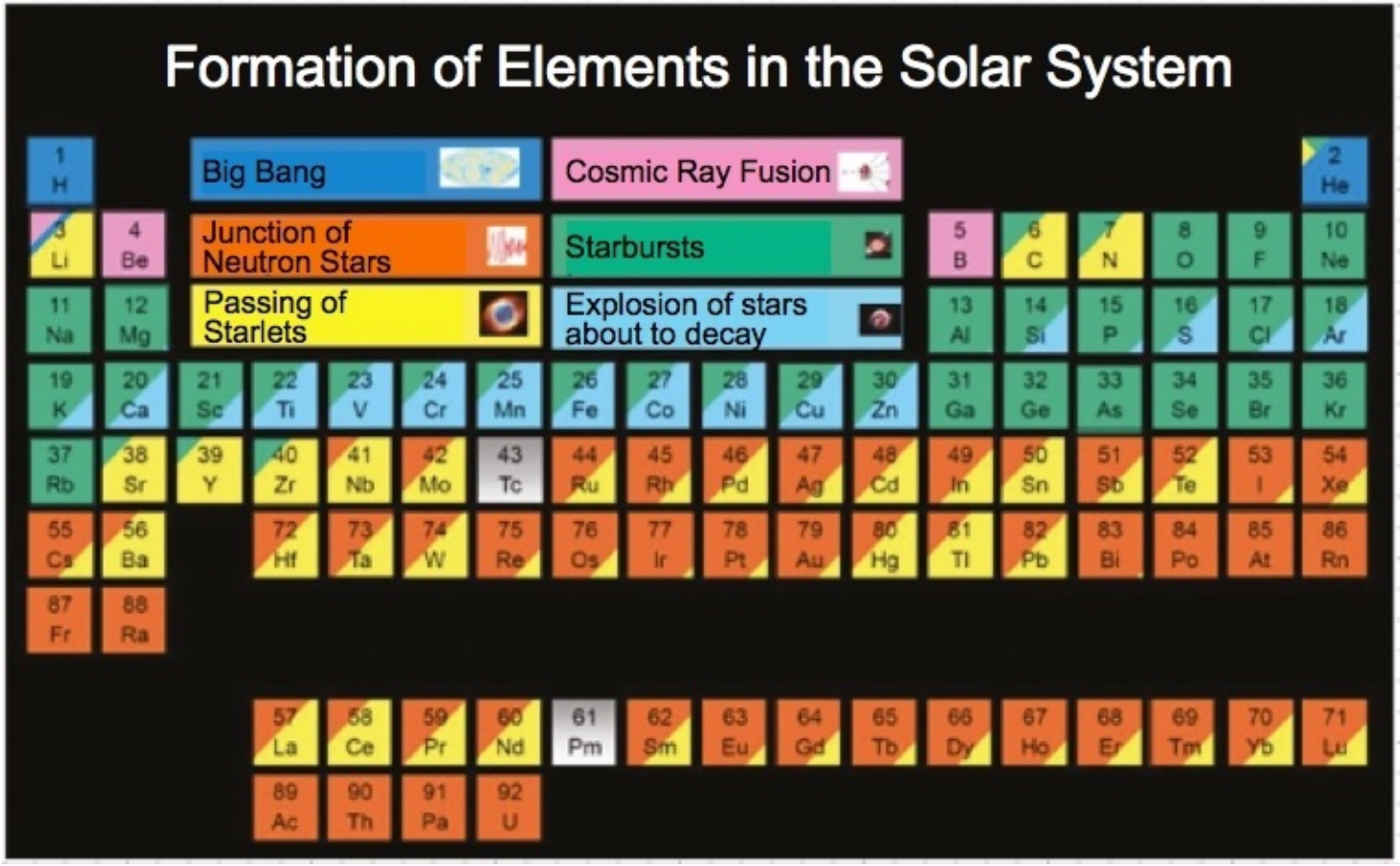
Formation of Elements in the Solar System
Big Bang
Cosmic Ray Fusion
Junction of Neutron Stars
Starbursts
Passing of Starlets
Explosion of stars about to decay
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 Ar
19 K
20 Ca
21 Sc
22 Ti
23 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
39 Y
40 Zr
41 Nb
42 Mo
43 Tc
44 Ru
45 Rh
46 Pd
47 Ag
48 Cd
49 In
50 Sn
51 Sb
52 Te
53 I
54 Xe
55 Cs
56 Ba
72 Hf
73 Ta
74 W
75 Re
76 Os
77 Ir
78 Pt
79 Au
80 Hg
81 Tl
82 Pb
83 Bi
84 Po
85 At
86 Rn
87 Fr
88 Ra
57 La
58 Ce
59 Pr
60 Nd
61 Pm
62 Sm
63 Eu
64 Gd
65 Tb
66 Dy
67 Ho
68 Er
69 Tm
70 Yb
71 Lu
89 Ac
90 Th
91 Pa
92 U

Dr. İlhami PEKTAŞ

He is graduated from METU Metallurgy and Materials Engineering Department. He has MS post graduate degree in the same Department of METU and Ph.D degree from Mechanical Engineering of Gazi Machinery Department. He has worked as Manager in Tübitak, Mitaş TAS, Ereğli Iron and Steel and Çelbor Steel Tube Plants for many years. Now he works as a Coordinator of Ostim Technology Research and Development Center and the Anatolian Railway Transportation Systems Cluster (ARUS).